March 4, 1957 50 cents

AVIATION WEEK

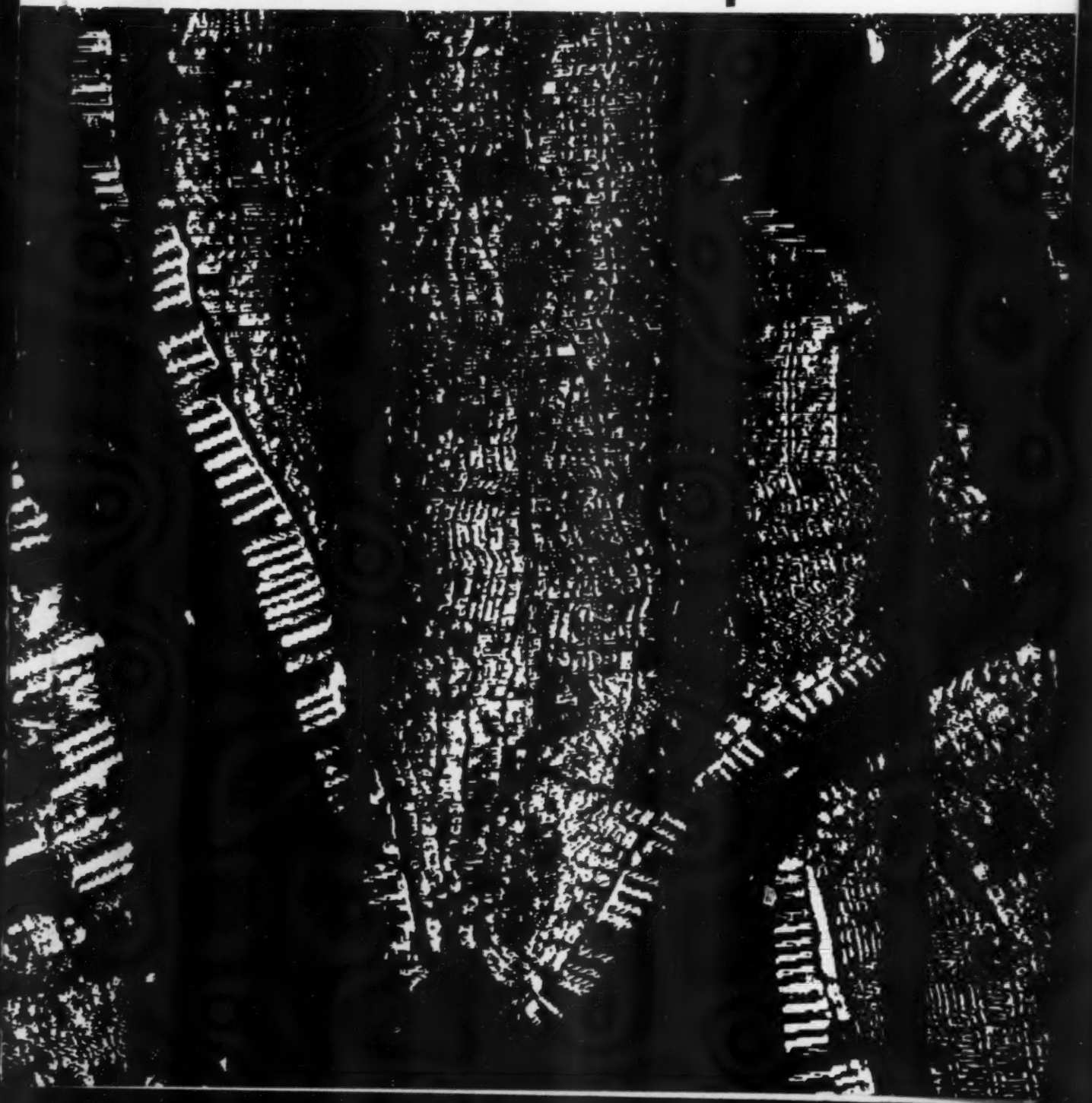
A McGRAW-HILL PUBLICATION

EXCLUSIVE REPORT:

Infrared Revival Challenges Radar

●

Infrared Maps Manhattan



where access is limited . . .

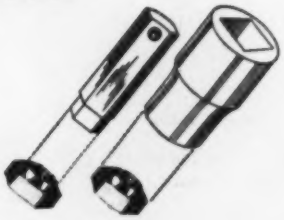
KAYLOCK®
all-metal self-locking nuts

INTERNAL or EXTERNAL WRENCHING HEX NUTS

Tensile nut strength with shear nut height—the lightest of all self-locking nuts.

LIGHT WEIGHT • FULL STRENGTH • LOW HEIGHT

Another Kaynar first—the new KAYLOCK HEX NUT provides a substantial reduction in wrench clearances required for installation of AN363, AN364 and AN365 self-locking nuts. (Counter bore diameters, spot face diameters and edge distances may be greatly reduced.)



This one Kaylock hex nut is approved for all three Air Force-Navy standards: AN363, AN364 and AN365. For more information, write for our catalog.

Trade Mark

THE KAYNAR COMPANY • KAYLOCK DIVISION, Dept. AB, Box 2001, TERMINAL ANNEX • LOS ANGELES 54, CALIFORNIA

Canada Distributor: Aberdorn Aero Ltd., Montreal

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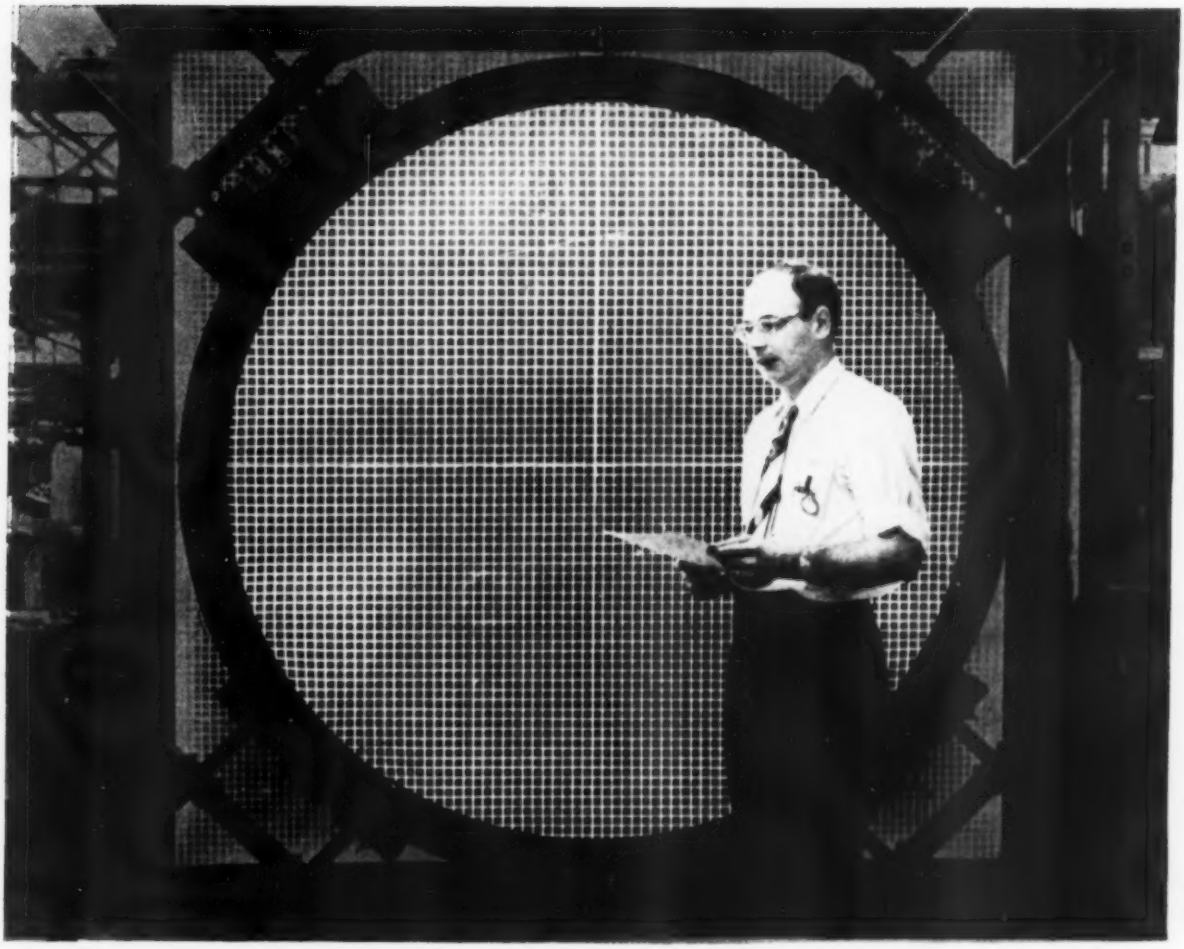

In the circle:

Fidelity by the foremost in Stretched Plastics

IN THE circle above, you see an engineer standing *between* a sheet of s-t-r-e-t-c-h-e-d plastic and a grid board which checks the optical perfection of the material:
Convincing proof in a field in which Goodyear Aircraft Corporation has no peer.

As first to stretch-form a full-size aircraft canopy, Goodyear Aircraft engineering established the criteria for progress in this important field — pioneered two *unique* fabricating processes which (a) save weight, (b) solve long-standing problems of shattering and crazing in plastic windows and cockpit enclosures.

This experience and these processes can serve you well —just as they are serving production orders and orders for prototypes for such planes as the F-100A, F-101B, F-102A, F-106A, F4H and 707.

The choice is yours, depending upon the elongation to form, the details and complexity of your canopy configuration: the Goodyear Aircraft *Duotherm Process*— which first stretches the plastic as shown above, then forms it — or the *Monotherm Process* which *simultaneously* stretches and forms plastic in a single operation.

But whatever the process — call in Goodyear Aircraft and be assured of fidelity of fabrication by the foremost in stretched plastics! For engineering consultation, write: Goodyear Aircraft Corporation, Dept. 932AC, Akron 15, Ohio.

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GOODYEAR AIRCRAFT

Plants in Akron, Ohio, and Litchfield Park, Arizona
Rewarding Careers for Engineers

Monotherm, Duotherm—T. M.'s Goodyear Aircraft Corporation, Akron 15, Ohio

the world's largest manufacturing facility for aircraft seating
. . . for aircraft interior equipment

*which of these WEBER seats are standard equipment on the Boeing B-52?**

For the part that Weber plays in *today's* B-52's, consult the footnote. However . . . In Weber, there is a *"Department of Tomorrow."* To *build* well—for today's aircraft, is only part of the story.

RESEARCH has brought leadership to Weber. Escape systems are an example: more Weber designed ejection seats are flying today than any other independent firm. And Weber is readying designs for safe ejection systems to meet the ever more critical environments in which tomorrow's flight vehicles will operate.

a World of experience in: Pilot and crew seats, ejection seats, passenger seats, buffets and lavatory units.

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a subsidiary of Weber Showcase and Fixture Company, Inc.
2820 ONTARIO STREET, BURBANK, CALIFORNIA

* 1 *Pilot seat;* 16 *Co-pilot seat;* 6 *E.C.M. Operator seat;* 20 *Tail gunner seat.*

AVIATION CALENDAR

Mar. 5-7—Fifth Annual Air Safety Forum, Air Line Pilots Assn., Hotel Shoreland, Chicago, Ill.

Mar. 7-9—National Conference on Aviation Education, Hotel Mayflower, Washington, D. C.

Mar. 11-15—1957 Atomic Exposition including Nuclear Engineering & Science Congress, 5th Atomic Energy in Industry Conference and 5th Hot Laboratories & Equipment Conference, Convention Hall, Philadelphia, Pa.

Mar. 14—Flight Testing of Very High Performance Aircraft, NACA, Los Angeles.

Mar. 14-15—Flight Propulsion Meeting (Classified), sponsored by IAS, Hotel Carter, Cleveland, Ohio.

Mar. 18-21—Pacific Coast Plastics Exposition, in conjunction with The Society for Plastics Industry, National Conference, Shrine Exposition Hall, Los Angeles.

Mar. 18-21—National Convention, Institute of Radio Engineers, New York Coliseum and Hotel Waldorf-Astoria, New York.

Mar. 18-21—First Military Automation Exposition, New York Trade Show Building, 500 Eighth Ave., New York. For details write: Richard Rimbach Associates, 845 Ridge Ave., Pittsburgh 12, Pa.

Mar. 18-21—Second Annual Conference, Gas Turbine Power Division of the American Society of Mechanical Engineers, Hotel Sheraton-Cadillac, Detroit.

Mar. 23—New England Region American Helicopter Society, General Electric Co., Schenectady, New York. For details write: John E. Ryan, General Electric, Lynn, Mass.

Mar. 25-29—Tenth Western Metal Congress, Ambassador Hotel, Los Angeles.

Mar. 26-28—Sixth Weather Radar Conference, American Meteorological Society, Cambridge, Mass.

Mar. 27-29—Educational Colloquium on Radiation Effects on Materials, sponsored by Office of Naval Research and Glenn L. Martin Co., Johns-Hopkins University, Baltimore, Md.

(Continued on page 6)

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Vol. 66, No. 9

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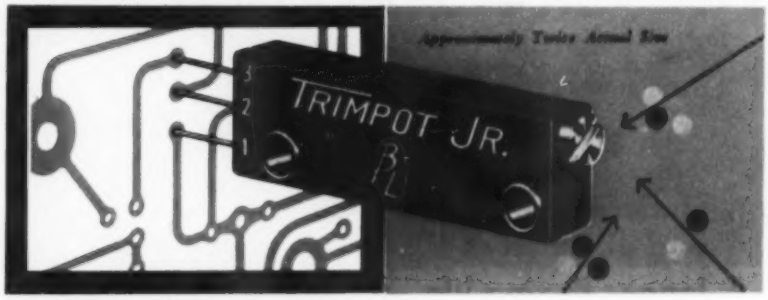
Bourns NEW TRIMPOT JR.*

- micro-miniature size
- high power rating
- humidity proof

*Trade Mark



This micro-miniature potentiometer is designed for use with printed circuit boards and modular-type assemblies, and is derived from Bourns' original TRIMPOT.® The new TRIMpot JR. is only 3/16"x 5/16"x 1" in size. Seventeen units can be mounted in one square inch of panel space. Power rating is 2 watts, and maximum operating temperature is 175°C.

The TRIMpot JR. is built to meet or exceed government specifications for humidity, salt spray, vibration, acceleration, and shock. This potentiometer features a 15-turn screwdriver adjustment and 1½", 0.016" diameter leads. The shaft-clutch assembly idles when the mechanical limits are reached, thus preventing possible damage from forcing of adjustments. The TRIMpot JR. is mounted with 2-56 screws through stainless steel eyelets on ¾" centers.

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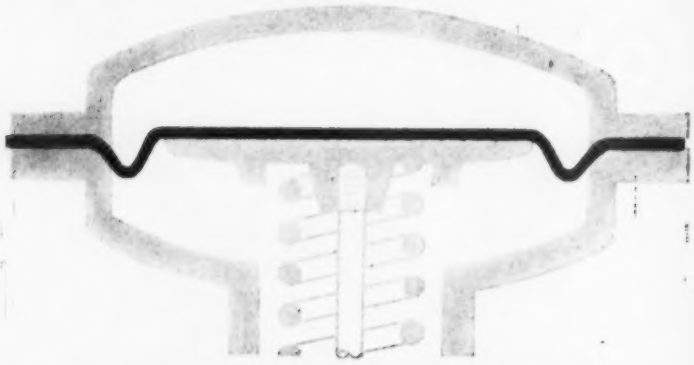

"aircraft quality"

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1. modern fabrics and elastomers
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6. longer strokes

Originator of the long stroke, deep convolution piston seals, Bellofram offers designers and manufacturers, diaphragms of aircraft precision quality. Now you can specify and obtain Bellofram diaphragms made by the most advanced methods, with modern fabrics and elastomers. Bellofram diaphragms are designed and manufactured to last longer and give substantially more flexing life . . . economically at a competitive price.

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Working Temperatures	−110°F to 450°F
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Materials	Practically any modern fabric and elastomer: from Nitrile Rubber & Nylon to Silicone Rubber & Dacron

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West Coast Office: MILTON W. McAVOY, 811 Cory Drive, Inglewood, California

AVIATION CALENDAR

(Continued from page 5)

Apr. 2-5—National Aeronautic Meeting, Aeronautic Production Forum and Aircraft Engineering Display, sponsored by Society of Automotive Engineers, Hotel Commodore, New York.

Apr. 3-5—Spring Meeting, American Rocket Society, Sheraton Park Hotel, Washington, D. C.

Apr. 13—Third Annual College Industry Conference, State University of Iowa, Iowa City, Iowa.

Apr. 17-20—Eighth Annual Conclave, Arnold Air Society, including aviation equipment display, Hotel New Yorker, New York, N. Y.

Apr. 22-24—Second Annual Jet Engine Hydraulics Symposium, Hotel Statler, Detroit, Mich.

Apr. 23-25—Annual Convention, International Airline Navigators Council, Piccadilly Hotel, N. Y.

Apr. 29—Third Flight Test Instrumentation Symposium, Statler Hotel, Los Angeles.

Apr. 30—Atlantic Rate Commodity Rate Board Meeting, International Air Transport Assn., Torquay, Devonshire, England.

May 1-3—Spring Meeting and Exhibit Society for Experimental Stress Analysis, Hotel Statler, Boston, Mass.

May 5-8—30th Annual Convention, American Assn. of Airport Executives, Shamrock Hilton Hotel, Houston, Tex.

May 6-8—28th Annual Meeting, Aero Medical Assn., Shirley Savoy Hotel, Denver.

May 8-11—13th Annual National Forum, American Helicopter Society, Sheraton Park Hotel, Washington, D. C.

May 13-15—National Conference on Aeronautical Electronics, sponsored by Institute of Radio Engineers, Dayton, Ohio.

May 20-23—Second Annual Design Conference, sponsored by the Machine Design Division of American Society of Mechanical Engineers, N. Y. Coliseum, New York.

May 24-June 2—22nd Paris Air Show, Society of French Aircraft Constructors, Le Bourget Airport, Paris.

June 1-9—First Annual National Aviation Trade Show, Monmouth County (N. J.) Airport.

June 7-8—30th Annual Homecoming and Reunion, Parks College, East St. Louis, Ill.

June 23-25—29th Annual Meeting, Aviation Distributors & Manufacturers Assn. The Broadmoor, Colorado Springs, Colo.

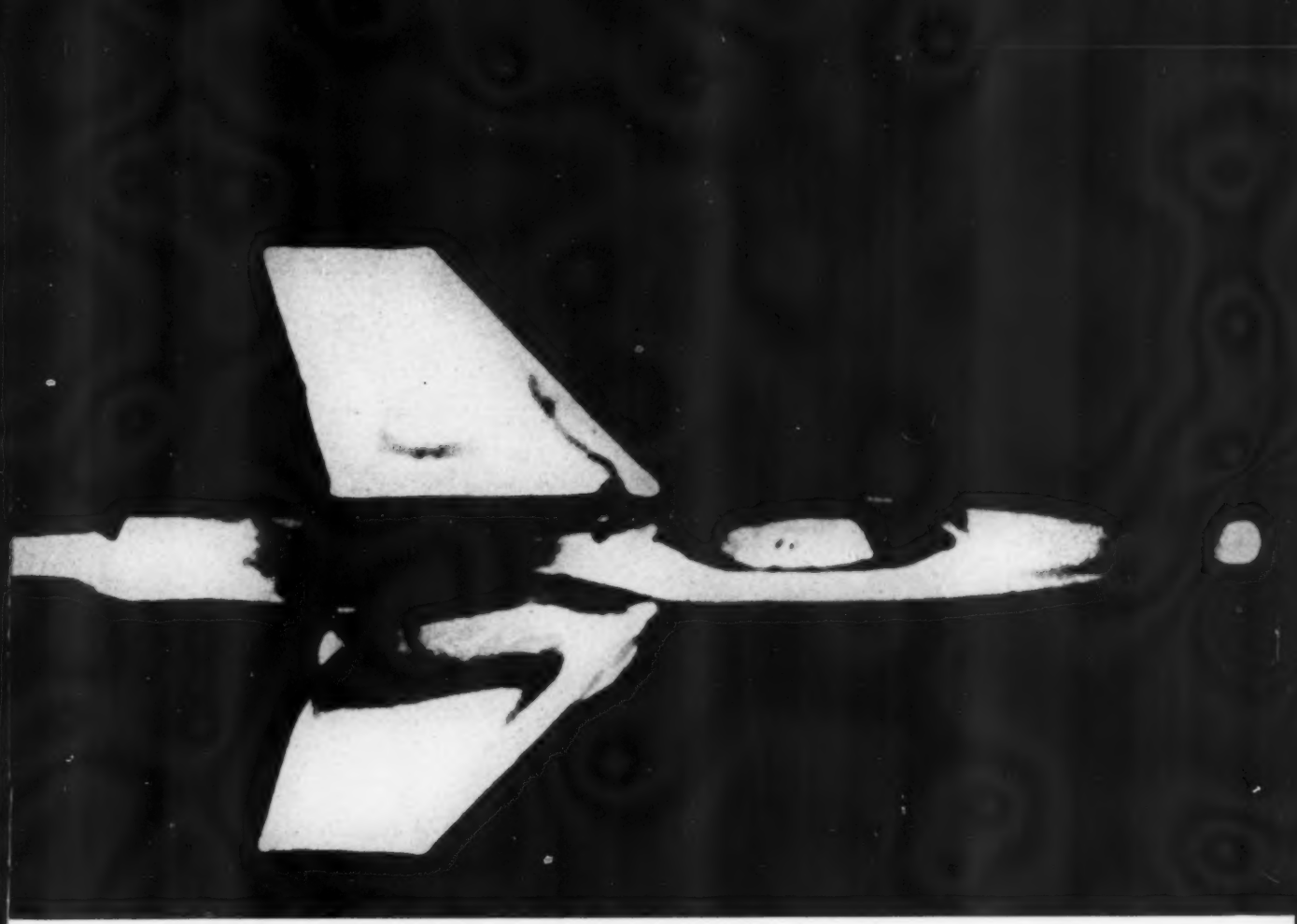
July 2-11—24th National Soaring Contest, Elmira, N. Y.

July 12-13—British Lockheed International Aerobatic Competition, the National Air Races (third round) and the King's Cup Air Race, Coventry Civil Aerodrome, Bagington, England.

Aug. 20-23—Western Electronic Show & Convention Board of Directors, Cow Palace, San Francisco, Calif.

Sept. 1-6—Sixth International Aeronautical Conference Royal Aeronautical Society and Institute of the Aeronautical Sciences, Folkstone and London, England.

Sept. 2-8—1957 Flying Display, Society of British Aircraft Constructors, Farnborough, England.



thermal thicket

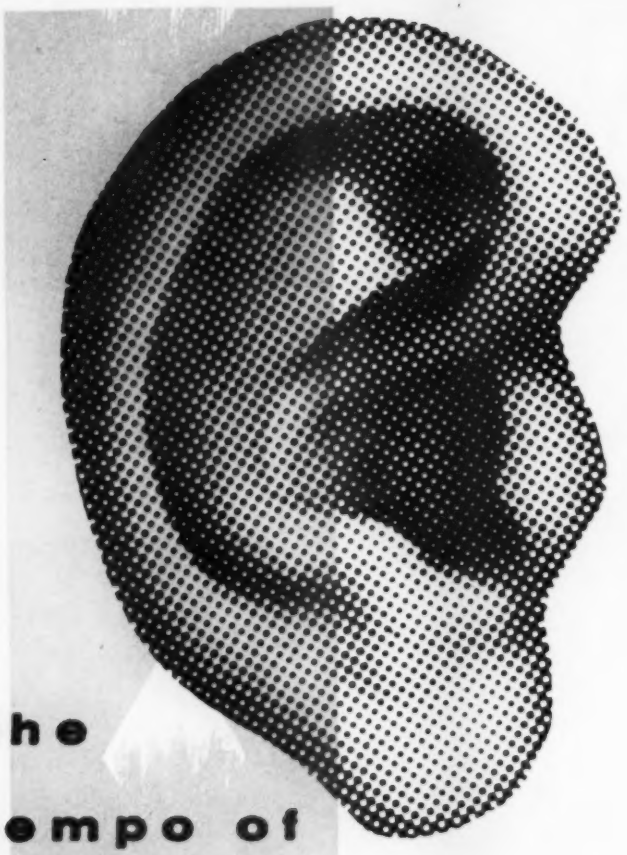
The thermal barrier which now limits the speed of ultra high speed aircraft can be cracked. Needed: Structural components of elevated temperature alloys. Problems: Finding the right alloys; making them easy to forge and machine with regular production-line tools; maintaining uniformity of physical properties in production lots.

Right now, Carpenter is producing elevated temperature alloys which set new standards for consistent ability to meet tough aircraft specifications, high quality, improved forgeability and machinability. Engine builders find them ideal for many critical parts. Forge shops can work them to closer tolerances, get better finishes that require far less than usual machining. Work goes faster. Rejects are fewer.

You can get the full story of these alloys — their application, fabrication and engineering properties — in the new booklet, "Carpenter Alloys for Elevated Temperature Service". Get your personal copy by writing on your Company letterhead. The Carpenter Steel Company, 128 W. Bern Street, Reading, Pa.

Carpenter STEEL

Improved alloys for elevated temperature service



tuned to the tempo of tomorrow

Open ears lead to the open thinking that made possible today's rocket powerplants. They are alert ears—ears acutely sensitive to the unsolved problems that must be conquered in designing powerplants for the vehicles of the future.

RMI puts a premium on just such thinking. Its engineers and scientists form a talented, alert team, efficiently and effectively meeting the rocket power needs of tomorrow.

Engineers, Scientists—Perhaps you, too, can work with America's *first* rocket family. You'll find the problems challenging, the rewards great.

Power for Progress

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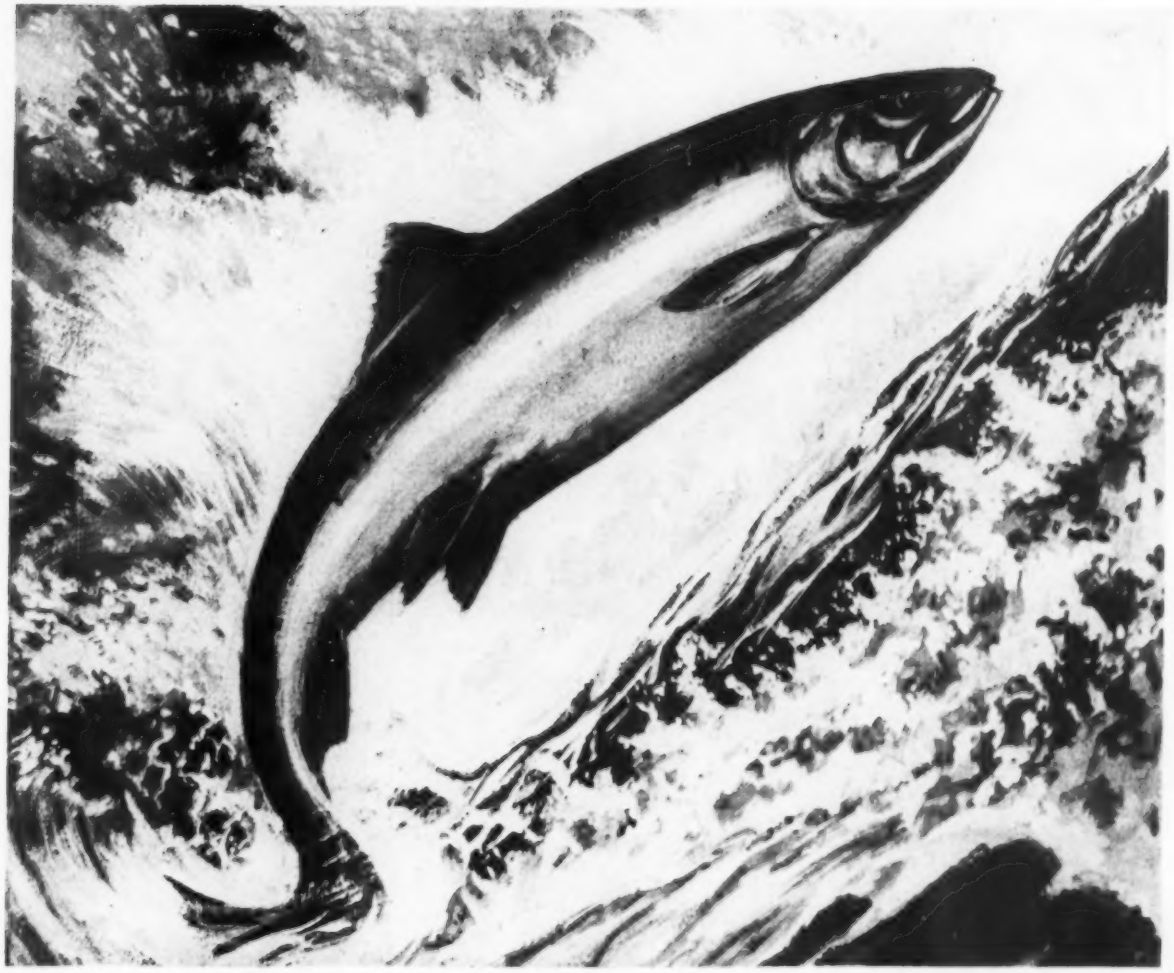


Upstream!

Most people watching a salmon swim upstream wonder how he does it. Seems like a lot of exertion to move from one wet spot to another. To the salmon, though, the compulsive drive upstream cannot be denied.

The titanium industry also has been fighting upstream these past five years. A succession of production rapids and metallurgical waterfalls have been surmounted. The dangerous hydrogen whirlpool was successfully skirted. The industry has now moved through the less white headwaters to fully competitive equality with other structural metals.

Titanium alloys of high strength, light weight and outstanding corrosion resistance are available from T.M.C.A. in all mill forms and in a full range of sizes and gages — sheet, bar, billet, extrusions, tubing and wire. Special heat-treated sheet of very close gage and flatness tolerances is in production for advanced aircraft and missiles.

Further expansions of sponge production and metal finishing facilities at T.M.C.A. are bringing titanium within reach of an ever-expanding market. Technical information and specialized engineering services are available for solving those applications having a strength, weight or corrosion challenge.

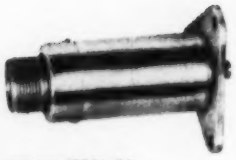
. . . FIRST IN Titanium

TITANIUM METALS CORPORATION OF AMERICA, 233 Broadway, New York 7, N.Y.

AIRCRAFT AND MISSILE CONTROLS

The components shown here are but a small cross-section of the entire range of products we design and manufacture. Many variations of these units have been created to suit specific requirements. A large part of our design effort is also devoted to the development of complete control systems having outstanding performance and reliability.

We invite you to discuss your present and future requirements on components or control systems with our engineering staff. Data sheets for current models are available. Please direct your inquiry to our plant at Danbury, Connecticut.

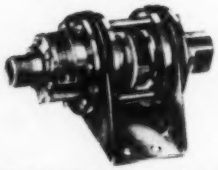


High Temperature (650° F.) PRESSURE SWITCH, Type 6576

CONSTRUCTION: All-welded stainless steel. Precision stacked-capsule sensing element. **TEMPERATURE RANGE:** —65° F. to 650° F. **ADJUSTMENT RANGE:** 20 to 75 psia. **RESET VALUE:** 2 psi. **CONTACTS:** 1 amp inductive snap action. **DIMENSIONS:** Diameter 1¼"; length 3½".

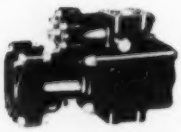
Differential PRESSURE SWITCH, Type 6580

DIFFERENTIAL ADJUSTMENT RANGE: 4" to 125" of water. **SYSTEM PRESSURES:** up to 60 psi. **RESET VALUE:** 1" to 3" of water (proportional to operating point). **EXTERNAL ADJUSTMENTS:** Separate adjustment of operating point and reset value. Alternate style provides two adjustable operating points with fixed reset values.



PRESSURE SWITCH (High Vibration), Type 6885

Integral vibration isolation. External adjustment doubly locked. Small physical size. Airframe, missile, rocket applications. **OPERATING RANGES:** 1 to 800 psi. **SYSTEM PRESSURES:** 5 to 3,000 psi. Available in single and dual assemblies, and in absolute pressure sensing model.



After Burner Fuel Control, Type 141RL37

Schedules afterburner fuel flow as a function of compressor discharge pressure absolute. Unique dual poppet design maintains constant pressure drop across the metering poppet; makes fuel flow a linear function of metering poppet lift. External adjustments permit slope and zero-shift alterations of flow versus compressor discharge pressure curve. **RATED FLOW:** 3,500 to 35,000 lbs/hr.

Dual Hydraulic Pressure Gauge, Type 6966

Dual hydraulic pressure indication within envelope normally occupied by single indicator. **DIAL SIZE:** 1⅞". Instant recognition of system condition—pointers horizontal denote full pressure. No translation. No reading of figures. Safety blow-out disc behind panel.

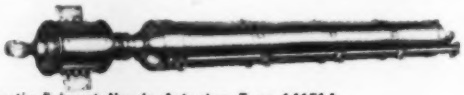
Rotary Torque Booster, Type 141F12

Controls fuel or hydraulic pressure to apply high level-output force in response to low level input force. May be inserted in mechanical control linkage to reduce pilot effort. 8 to 1 torque amplification. Simple mechanical design. Poppet operated—not sensitive to dirt clogging. Output shaft will accept 1½° misalignment. Inherently stable.

"VAPOFLASH" Temperature Measuring Probe

A high temperature measuring element intended primarily for gas turbine applications. Provides proportional pneumatic output for 100° F. change in gas temperature. Connection of several units in parallel for averaging permits control of exhaust gas temperatures by variation of exhaust nozzle area, afterburner fuel flow, main engine fuel flow, or other dependent variable. **OPERATING RANGES:** 1,000° to 1,500° F.

Alternate style (Vapoflash Thermal Switch) provides actuation of electrical contacts within the range of 1,000° to 1,500° F.



Pneumatic Exhaust Nozzle Actuator, Type 141F14

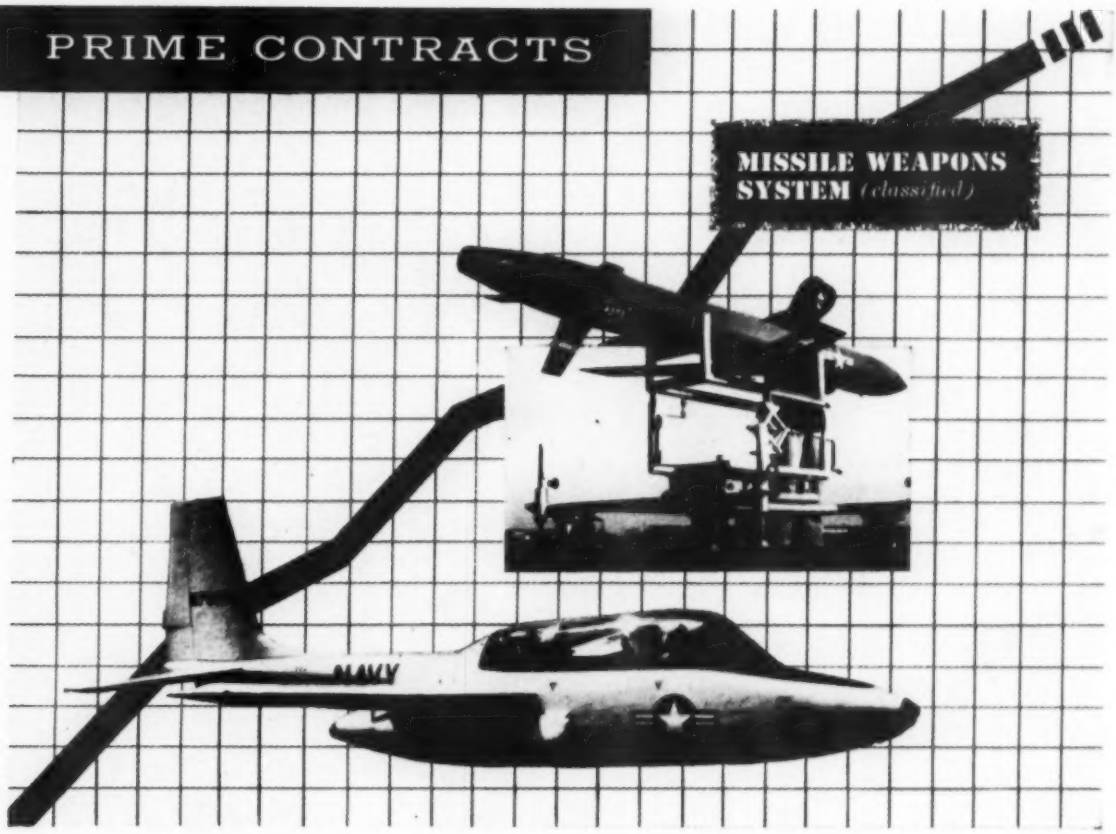
Actuators are spaced equally around the tail pipe of a turbojet engine. Use compressor discharge pressure directly to position the exhaust nozzle. Actuator tandem four-piston design provides very high forces within small cross-sectional area. Synchonizing valves act to equalize position of driving points around exhaust nozzle. **EACH ACTUATOR:** 5,000 lbs. force with air at 200 psi. **INLET AIR TEMPERATURE:** 935° F. max. **BORE:** 3". **BARREL LENGTH:** 31.5". **MATERIALS:** Stainless steel, bronze.

MANNING, MAXWELL & MOORE, INC.

AIRCRAFT PRODUCTS DIVISION • DANBURY, CONNECTICUT • INGLEWOOD, CALIFORNIA

OUR AIRCRAFT PRODUCTS INCLUDE: TURBOJET ENGINE TEMPERATURE CONTROL AMPLIFIERS • ELECTRONIC AMPLIFIERS PRESSURE SWITCHES FOR ROCKETS, JET ENGINE AND AIRFRAME APPLICATIONS • PRESSURE GAUGES THERMOCOUPLES • HYDRAULIC VALVES • JET ENGINE AFTERBURNER CONTROL SYSTEMS.

PRIME CONTRACTS



At Temco GROWTH tells the story

Growth — in prime contracts earned, for example, tells the Temco success story.

In January, Temco announced its third prime contract from the U. S. Navy within a seven-month period. This 16-million-dollar order, for a classified guided missile weapons system, is another Temco engineering accomplishment, another advance in the company's rapid growth as a prime contractor.

In June 1956, the Navy selected Temco's TT-1 jet aircraft to become the nation's first primary jet trainer. Just six months later, the Navy ordered the Temco rocket-powered XKDT-1 rocket-powered missile target.

These significant events cap eleven years of sturdy growth at Temco. Together with other aircraft, missiles and weapons systems now in development, these prime contracts are building Temco's prominent position in America's aircraft industry. For the engineer who seeks a truly rewarding career, they spell out a story of challenging opportunity.

Mr. Joe Russell, Engineering Personnel
Room 103-D, Temco Aircraft Corp., Dallas, Texas

Please send me complete details of the Temco story of unusual opportunities for creative engineers. I am especially interested in _____

_____

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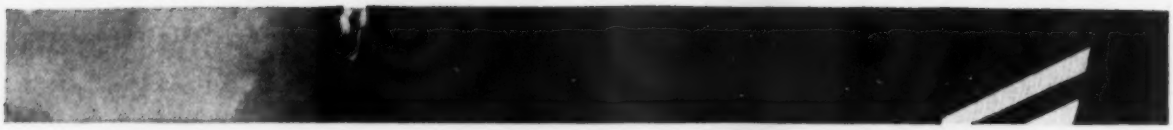
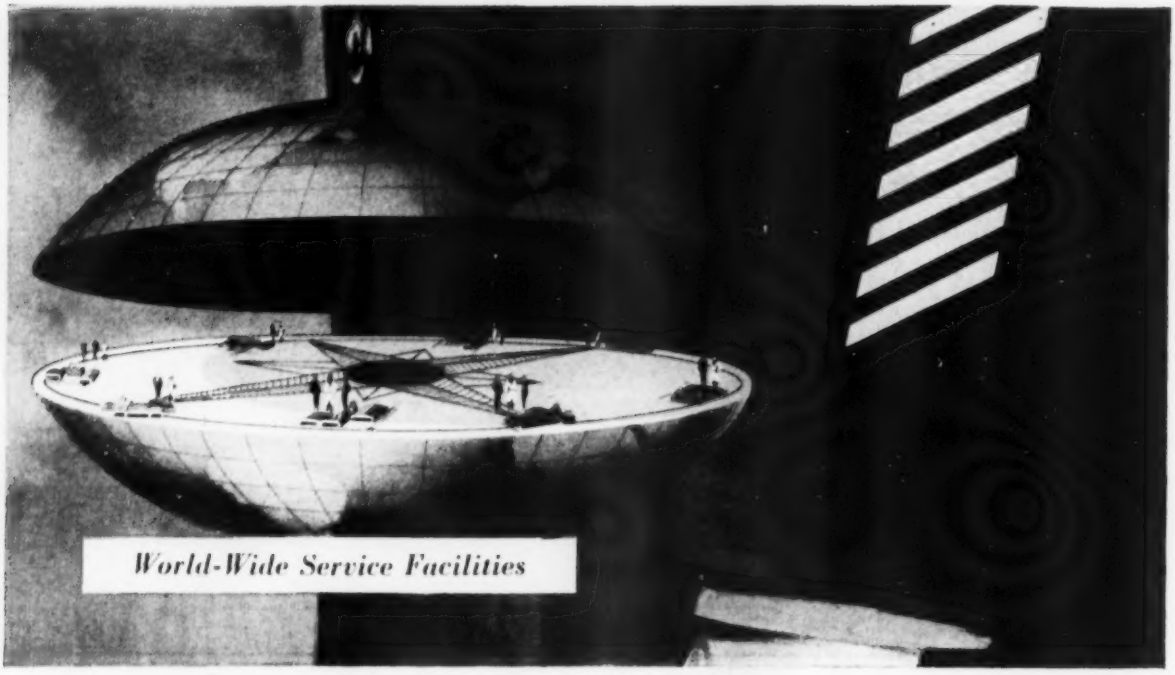


A VETERAN SERVICE ORGANIZATION



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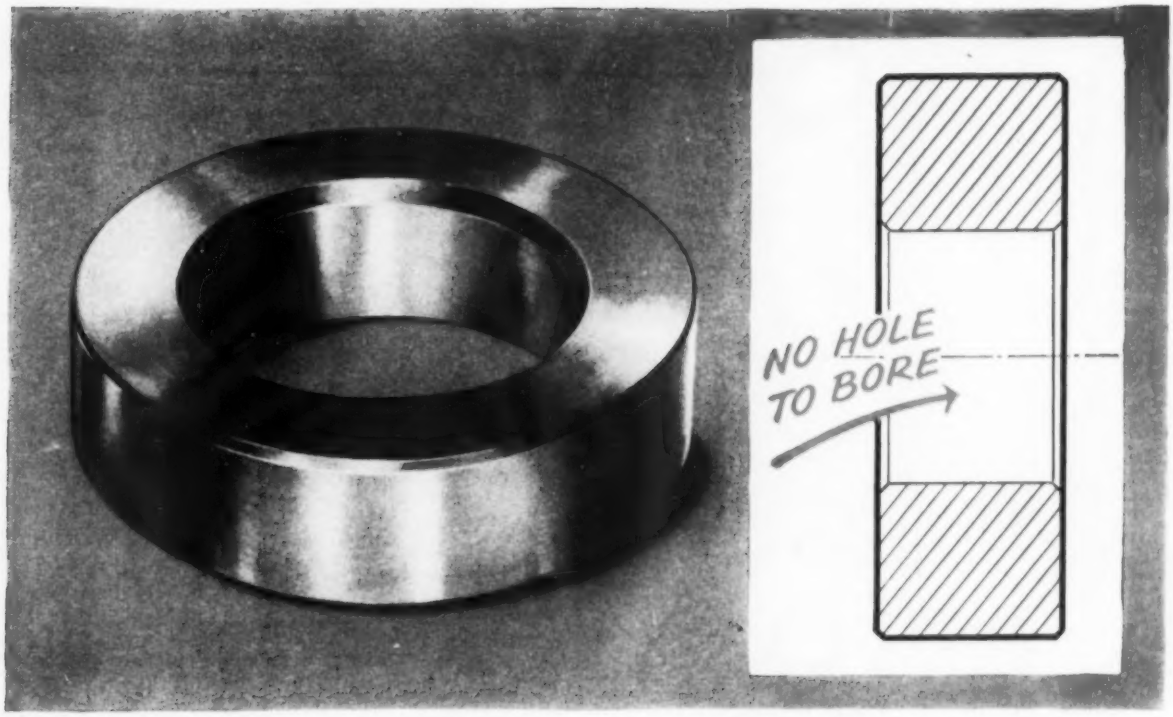

Steps up gear blank production 300% by switching from bar stock to TIMKEN® steel tubing

AN engine manufacturer felt that his gear blanks were costing him too much to make. The center hole had to be bored out of solid bar stock. It took a whole hour to turn out 29 blanks. And a lot of steel was wasted in the process.

So the manufacturer discussed his problem with metallurgists of the Timken Company, experts in fine alloy steel. After study they recommended a change in production methods together with a switch to Timken® seamless steel tubing in place of bar stock.

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Machining costs have been cut by more than half. And because the center hole is "built-in", no steel is wasted.

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which can replace rubber tubing

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It's now possible to have the strength and corrosion resistance of metal for use in free-flowing Freon, hydraulic, pneumatic or drain lines. Greater dependability and less deterioration are now attainable with flexible metal hose and ducting in places where synthetic and rubber hose usage is marginal because of excessive temperatures and pressures. And, it's at last feasible to refuel at high altitude with a long-lasting flexible *metal* hose.

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For further information . . write in confidence to Batavia or: Russell Engineering, 2205 Grand Avenue, Kansas City; 2140 Westwood Boulevard, Los Angeles; C. F Russell & Company, 146 4th Avenue, Bay Shore, Long Island. Your inquiry will receive prompt attention.

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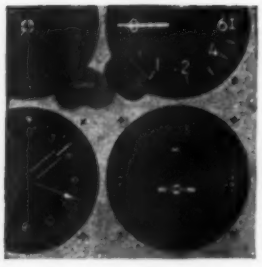
of Collins midget-sized giant performer



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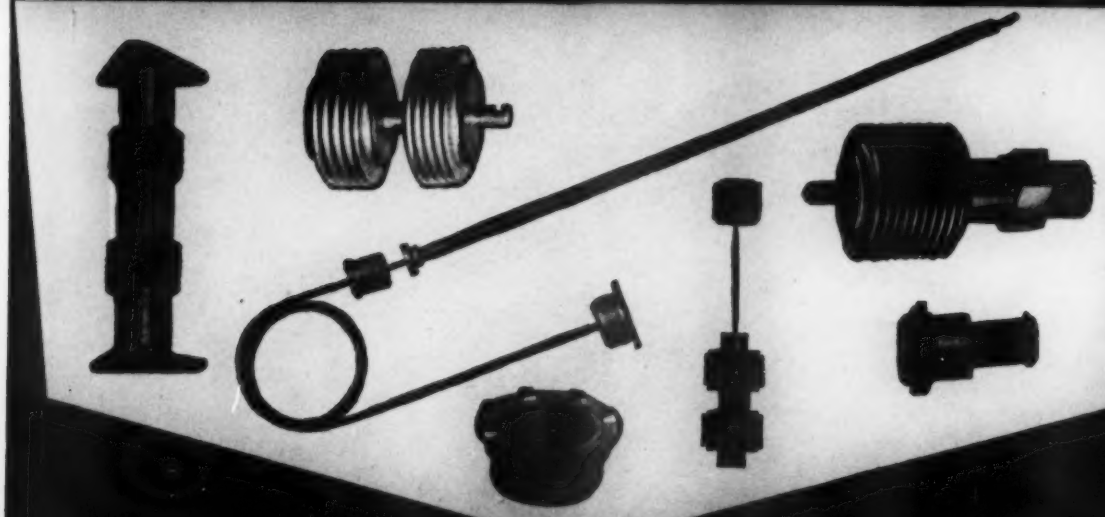
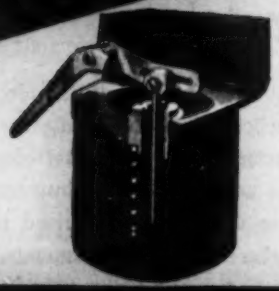


No matter why or how the bellows principle enters into an assembly, Fulton Sylphon can assemble the right bellows and related accessories or mountings into a complete device that meets your specifications. In doing this Fulton Sylphon offers important design help, specialized skill in joining bellows with other members, and modern production facilities for on-time deliveries.



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COVER: Infrared photo of Manhattan Island made six years ago with equipment developed by Servo Corporation of America. Present day infrared mapping systems provide considerably better resolution. For exclusive Aviation Week report on infrared and its aviation applications see page 50. The photo, made at 10 a.m., was from an altitude of 3,000 ft. At a speed of 165 mph. it is a magnified view of the map on page 51.

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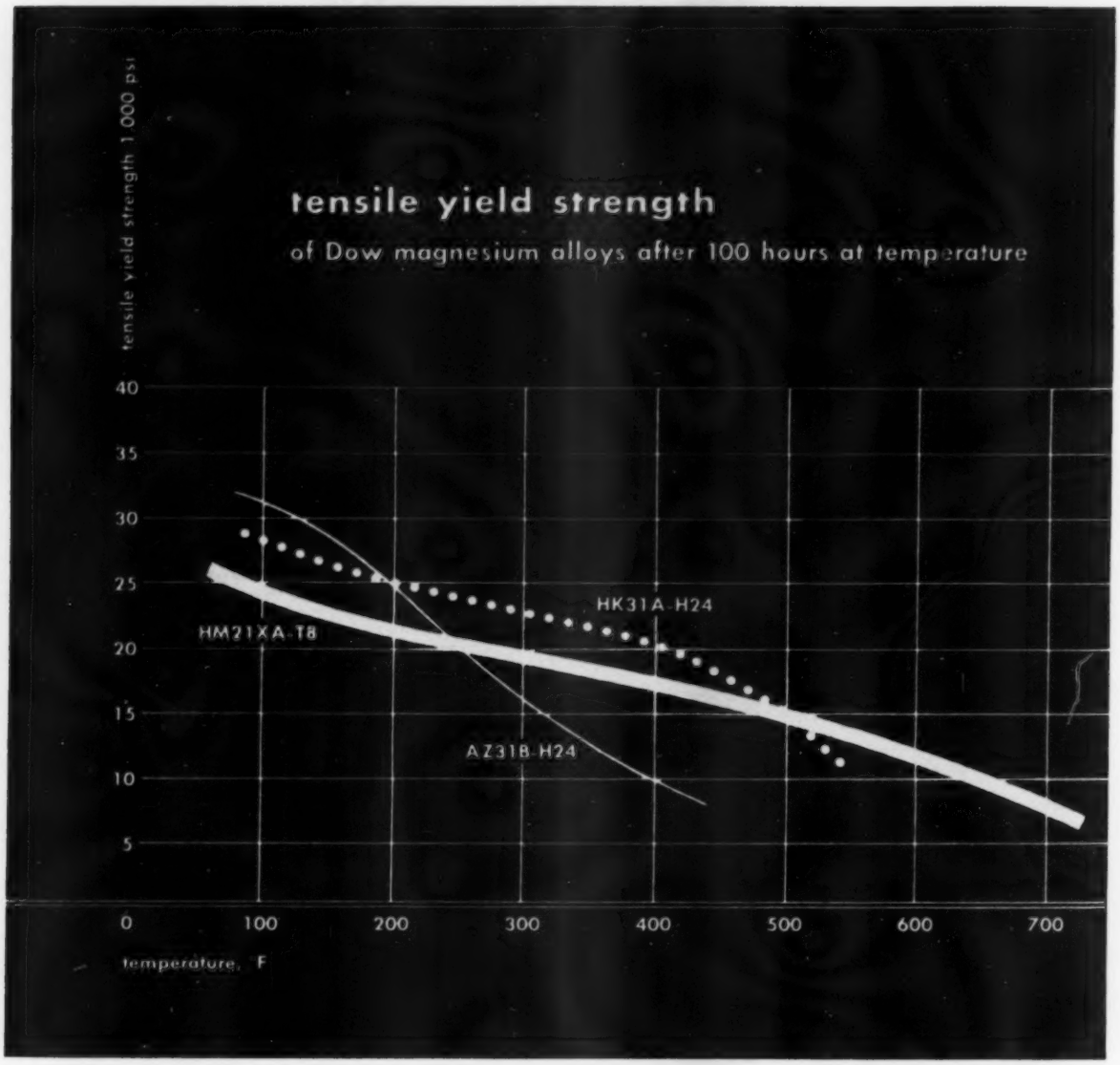

New magnesium alloy holds properties for 100 hours up to 700°F.

Dow Magnesium HM21XA-T8 alloy extends further the range of conditions under which light metals can be used in aircraft design. Second in the series of sheet alloys designed specifically for elevated temperature applications, it supplements the excellent characteristics of HK31A alloy.

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Magnesium lightness is combined with strength at elevated temperature in HM21XA-T8, offering new ways to save weight or gain increased rigidity in the design of missiles and aircraft. This alloy is supplied in the -T8 temper and can be formed in this temper without the need for further heat treatment after fabricating. Samples of HM21XA-T8 along with detailed information are available. Contact your nearest Dow Sales Office or write to THE DOW CHEMICAL COMPANY, Midland, Michigan, Department MA 1400A-1.

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EDITORIAL

Another Blow at Research

Mr. Frank D. Newbury has won his two year fight to become czar of all military research, development and production programs. His victory is another in a series of blows to the cause of aeronautical research and development emanating from the top civilian levels in the Pentagon, blows that are seriously restricting the scope and slowing the pace of this vital effort.

We have already detailed the strangulation of the research and development program caused by the constant level budget concept which has been accepted Department of Defense policy for the last several years.

Newbury Victory

The Newbury victory is a symptom of another disease attacking the roots of research and development. This is a general downgrading and "pooh-poohing" of the importance of basis research. It has its origin in elder graduates of the American industrial system whose technical education came just after sail had given way to steam and more than a quarter century before the technical revolution wrought by nuclear fission. These men who pride themselves on being "hard-headed" practical engineers grew up in an era of American industrial development that was nourished on technical principles provided by the prior half century's basic research. The application of these principles in the great industrial complexes where these men worked was so far removed in the time scale from the basic research on which they were based that the connection was virtually invisible.

Today the swift pace of engineering has just about exhausted the reservoir of basic scientific knowledge accumulated by a century of research. To maintain its technical pace, engineering needs an accelerated and expanded assault on the basic frontiers of knowledge by the scientists. Without a major series of scientific breakthroughs all along the boundaries of the unknown, the vast and successful engineering and production effort of this country will slow down to a dangerous walk in the foreseeable future. The link between basic research discoveries and their application to weapon systems and the rest of the industrial system is now so close and vital that no modern engineer even raises the issue. The modern partnership of the scientist and engineer is a vital, delicate, difficult and basically new relationship that must be nurtured, not divorced, if we are to maintain technical leadership for both war and peace. This is why the constant sneering at basic research, the downgrading of important research posts in the military structure and the resultant budgetary restrictions imposed by the "hard-headed" practical engineers whose technical outlook is limited to the steam turbine and internal combustion engine is producing such a dangerous threat to this science-engineering relationship.

In addition to the elevation of Mr. Newbury to be overseer of all things technical in the Pentagon there is other evidence of this trend. After creating assistant secretary posts for research and development in all three military services, it has now been decided to do without at least one of the new jobs. In the Air Force, where the post of Assistant Secretary for Research and Development has existed for several years, the vacancy created by the resignation of Trevor Gardner in protest over policies which Mr. Newbury heartily endorses has never been restored to its prior level. The post has been filled temporarily by Richard Horner, an extremely capable civil service career man, but his role has been vitiated by the handicap of serving only in an "acting" capacity. There has been no move by USAF Secretary Quarles either to give Mr. Horner permanent status in the post or to recommend appointment of another permanent assistant secretary for this job. Thus by a simple bureaucratic maneuver the cause of research and development within USAF has been moved down several notches in the command echelon.

Obstructionist Record

Mr. Newbury's view on advanced aeronautical development are well known to the aircraft industry. He bitterly opposed such developments as the KC-135 jet tanker and the P6M jet flying boat. He authored a plan to make development decisions on jet engines from paper designs instead of performance tests. He promoted a scheme to dictate new engine standards from his Pentagon office rather than rely on the fertile brains of the industry powerplant experts. One embittered research and development man who had the benefit of Mr. Newbury's philosophy during Pentagon service remarked that this philosophy if pursued to its logical conclusion would lead us to a policy of fighting World War III with the 1903 Model Springfield rifle because, "We are all tooled up for them. There are no development problems and it's a proven weapon."

Steady deterioration of the role of research and development in the Pentagon will prove to be a dangerous trend. It will make the Russian's avowed goal of surpassing us technically much easier.

—Robert Hotz

THERMOCOUPLES TAKE JET'S TEMPERATURE

Fenwal Harness Is Foolproof, Has Long Life

ASHLAND, MASS. — One mechanic who'd never seen Fenwal's Jet Engine Harness before installed it properly in fifteen minutes.

A fool would need a few minutes more to do the trick, but he'd have to be an idiot to get it on wrong. Fenwal makes the harness, which senses a jet's exhaust temperature with thermocouples, as simple as it can possibly be. It can be used for indication, control, or, with certain inexpensive modifications, for both.

The service-life of the harness is at least hundreds of hours in excess of Government specifications. The actual life can only be given as more than a thousand hours, since field tests were called off at that point, with absolutely no signs of failure apparent.

Fenwal pre-forms the harness to fit your engine, and the installer simply slips it around the tail cone. Only two bolts for each thermocouple lock the thermocouple to the harness and the harness to the mounting boss. All thermocouples are keyed, so that they can be installed only in the proper way.

Terminal studs have been eliminated — and vibration-induced breakage and short circuiting have been eliminated too. In place of studs are curved buttons on the thermocouples and flat buttons on the harness. These buttons make the contact between the thermocouple and the harness.

As for maintenance, nothing could be simpler. If it ever becomes necessary to replace a thermocouple, only two bolts are involved. Since the contact buttons are exposed to air flow, removal of moisture and foreign particles from them is virtually automatic. The harness itself needs no care, since it is sheathed in stainless steel, and the bus bars are insulated with a special hard asbestos.

RELIABLE AND FOOLPROOF — This Fenwal Jet Engine Harness senses jet engine temperatures with interchangeable thermocouples for indication and control purposes. It is exceedingly simple to install. It has been service tested for 1000 hours without failures.

You don't have to worry about the effects of differential expansion on the harness, either. The assembly is semi-flexible, and puts only light stresses on the bosses. The bosses don't have to be "beefed up."

The system performs at ambient temperatures up to 1200°F, and Fenwal is prepared to make systems for higher temperatures on request.

It is remarkably light. A four-thermocouple system with a 21-inch diameter harness, for instance, weighs only 3.6 pounds, bolts and all.

You will have no trouble integrating the system with your own indicator or control schemes, or both. The circuitry is simple, too, with balancing resistors in the thermocouple mounting pads for maximum control accuracy. Tolerances are such that no adjustments are needed when a thermocouple is replaced.

Contact your local Fenwal Sales Engineer, or write to Fenwal direct to learn how this system and other widely useful Fenwal concepts can solve temperature control problems now facing you. **Fenwal Incorporated, Aviation Products Division, 123 Pleasant Street, Ashland, Mass.**

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...PRECISELY

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Dr. L. L. Wheeler, vice president-industrial relations, Sperry Gyroscope Co., Division of Sperry Rand Corp., Great Neck, N. Y.

Honors and Elections

Claire L. Egtvedt, chairman of the Boeing Airplane Company, has been named the University of Washington's most distinguished alumnus for 1957. Each year the University's Alumni Association presents the "Alumnus Summa Laude Dignatur" award to an outstanding living graduate.

Donald W. Douglas, president of Douglas Aircraft Co., received a special award from the Los Angeles Council of Engineering Societies in recognition of his contributions and achievements in aircraft and missile engineering.

(Continued on p. 93)

INDUSTRY OBSERVER

► Prototype of Convair's Atlas intercontinental ballistic missile is scheduled to be test launched from USAF's Missile Test Center, Cape Canaveral, Fla., in about two months. Primary purpose is to test the missile's propulsion system. Missile configuration will not include the Atlas guidance system or true nose cone. Nose will be merely faired for test.

► Grumman Aircraft has won a Navy competition for a new airborne early warning patrol plane. Winning Grumman design calls for a flying boat configuration.

► Convair has a Navy order for two prototypes of a new flying boat anti-submarine-warfare aircraft. Powerplants will be Wright Turbo-Compound engines.

► Madigan Guided Missile Corp., an affiliate of Madigan Corp., Carle Place, Long Island, N. Y., is proposing to USAF and Navy a probe-and-drogue refueling aid embodying a heat-seeker principle similar to that used in Navy's Sidewinder missile. The system, adaptable to both bombers and fighters, embodies an infrared pulse system and seeker that combine to pull the probe and drogue together, eliminating much of the hit-and-miss approach now necessary in refueling operations.

► Bristol Aero Engines Ltd. has developed a new model of its Orpheus lightweight turbojet which operates in the 6,000 lb. thrust class. This compares with 4,850 lb. thrust for earlier models of the Orpheus.

► Douglas Aircraft has proposed an STOL transport (Model 90) for aerial resupply of carrier task forces at sea. The Douglas proposal involves an aircraft of 60,000 lb. gross weight using turboprop powerplants. Fairchild has also submitted a fleet aerial re-supply proposal embodying folding-wing models of the C-123 (AW Jan. 21, p. 50).

► General Electric's Evendale, Ohio, plant is studying design refinements aimed at improving thrust of the J79 turbojet by 10%-15%. J79 now has guaranteed thrust of 10,000 lb., with an afterburner adding approximately another 5,000 lb. Refinements may include a decrease in the compressor root diameter to increase blade length to handle more air and a change of blade configuration and spacing.

► Army has now laid down precise takeoff requirements for VTOL and STOL aircraft. A VTOL must get off the ground without any roll and clear a 50-ft. obstacle in 250 ft. STOL aircraft are allowed ground roll but must be able to clear a 50-ft. obstacle 500 ft. from its starting point.

► Bristol Olympus B. O1.6 split compressor turbojet that recently completed its official 150 hr. type test for a rating of 16,000 lb. thrust also has been run for 150 hr. at full takeoff power of 13,000 lb. thrust.

► Research by National Advisory Committee for Aeronautics' Langley Laboratories has spurred industry interest in jet augmented flap as a means of decreasing landing and takeoff speeds and distances of transport aircraft. NACA is investigating both the British system, with engines embedded in the wings, and its own system whereby diverted thrust is obtained from podded engines mounted on pylons (AW Oct. 15, p. 26). Almost every U. S. airframe manufacturer has viewed NACA's work in the field.

► Test pilots of Convair's supersonic B-58 Hustler have found that computed power settings for test flights are too high. To maintain desired airspeeds, pilots have to reduce the power settings from those first believed necessary. Pilots also say the Hustler passes through Mach 1 without any tremors or vibration. Only indication is when the Mach meter makes the jump.

► Princeton University is investigating stability and control characteristics of unducted flying platforms for the Army's Transportation Research and Engineering Command.

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Head and shoulders above the rest

Wherever you fly . . . from Alaska to the Horn . . . the exciting new Fairchild F-27 propjetliner outperforms all other aircraft in its class. Fastest and most versatile short-to-medium haul aircraft, the F-27 is powered by airline proven twin Rolls-Royce propjet engines.

Tailored to the needs of the airline operator and the air traveler, its spacious pressurized and air conditioned cabin provides seating for up to 40 passengers.

Cruising at 280 mph., the F-27 has exceptionally good short landing and takeoff performance. It's economical to operate, economical to buy.

Address inquiries to: R. James Pfeiffer, Executive Director of Customer Relations, Fairchild Engine and Airplane Corporation, Hagerstown 15, Maryland.

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THE FINEST AIRCRAFT FOR AIRLINES, CORPORATIONS AND MILITARY SERVICES.

Washington Roundup

Cause and Effect

Results of a press conference can sometimes go awry, as evidenced last week by press and stock market misinterpretations of remarks made by Defense Secretary Charles E. Wilson.

At his press conference, Wilson was asked just what factors would be considered in any possible change in the production rate of Boeing B-52 jet bombers. The following exchange resulted:

Wilson: The progress we have made ourselves with B-52 production, what we think the Russians may have made in their comparable airplanes and what the prospects are for some new planes that we have got, particularly the B-58.

Press: Is the (Convair) B-58 considered the successor plane to the B-52?

Wilson: Some people think that it is, and some people think it isn't. Depends on how much you refuel it and how you handle it.

Press: A competitor for the money though?

Wilson: Yes, largely.

Press: What do you think, sir?

Wilson: I could think better after I got the report of the test (of the B-58).

Next morning, two hours after the stock market opened, a news association reported from Wall Street:

"Stocks of Boeing Airplane and General Dynamics (Convair's parent company) moved widely on word that the government is considering replacing the Boeing B-52 bomber with a more modern plane.

"Boeing fell 3¾ to 48¼ while General Dynamics rose 1¼ to 60¼."

Still later, Boeing's stock had dropped by more than four points. By the end of the day's trading, however, it had recovered more than half its loss after the Air Force issued a statement that Boeing still had firm orders for 502 B-52 bombers costing about $8 million each.

Ceiling Zero

Rep. John Moss (D.-Calif.), chairman of the House Government Information Subcommittee, has asked Defense Secretary Charles E. Wilson to explain why a telephone recording of military weather forecasts ends with the statement: "This information is for military use only and dissemination to the public is not authorized."

Moss points out that the telephone extension is printed on the front of the Pentagon phone book and that "anyone in the world" can obtain the forecast "by calling the Pentagon from the corner drug store or from the Kremlin itself." Moss said his subcommittee has come across " a number of unusual applications of security, but this appears to be a new technique." He asked Wilson to cite his authority for this kind of "verbal classification." The subcommittee will quiz the Coolidge Committee on Classified Information and its staff next week on their recent report on Defense security policies.

Army or Wilson?

Army's sensitivity over its guided-missile role was demonstrated once again last week after Defense Secretary Wilson said Jupiter IRBM project has been "canceled" for all practical purposes.

The announcement was promptly denied by the Army, despite the fact that Wilson already has ruled that the Army-designed Jupiter will be operated by the Air Force when, and if, it is produced.

Both the Jupiter and USAF's competitive Douglas Thor will be continued, the Army said, and one or the other dropped only after an evaluation.

Wilson indicated that funds for the Jupiter will be sought only to finish "any hardware or tests that we clearly started to prepare for." The Defense Secretary ruled in November that any money for the Jupiter in Fiscal 1958 would come from USAF, and it is not expected that this branch of the services will donate generously and willingly.

On the subject of land-based ground-to-air missiles, Wilson said it is up to the Army to decide the relative merits of its Nike and the Navy-developed Talos.

Unprecedented Endorsement

Civil Aeronautics Board startled the aircraft industry last week with an unprecedented endorsement of Fairchild's F-27 turboprop transport. The endorsement was issued in the form of a press release on official CAB stationery.

The release quoted CAB members, who had just toured Fairchild's Hagerstown, Md., plant, as describing the F-27 as an aircraft that will give the "airlines a chance to furnish rapid, short-haul transportation."

Member Chan Gurney, for example, was quoted as saying the F-27 "will provide better service on a reasonable cost basis to the ultimate benefit of the carriers, the communities served and the general public." Harmar Denny and Chairman James Durfee, the other two members who made the trip, were equally enthusiastic.

In the eyes of Fairchild, and its competitors, the press release was as good as an official endorsement.

The CAB pointed out that Board members held a press conference last November after visiting the plants of Boeing, Convair, Douglas and Lockheed.

A press conference, however, lacks the selling quality and staying power of an official release. One competitor's representative also complained that in the November press conference, the Board "cautiously refrained from showing enthusiasm for any one plane" but praised, instead, the progress of jet development in general.

Congress

House Armed Services Investigating Subcommittee's scheduled long look into military procurement practices (AW Feb. 25, p. 354) got off to a slow and grinding start last week. Consensus is that it will be several weeks before the probe moves into airframe subcontracting practices. Other Hill developments:

• **CAB Appointment.** Public hearings on the nomination of Louis Hector to a Democratic post on the Civil Aeronautics Board are scheduled for March 13 before the Senate Commerce Committee. Thus far, there is no evidence of any opposition to the appointment, although several Democrats have expressed their disapproval of the administration's policy of appointing Eisenhower supporters to Democratic posts. Although a Democrat, Hector voted for Eisenhower in both 1952 and 1956.

• **Celler Report.** The House Anti-Monopoly Subcommittee, which conducted lengthy hearings on air transportation last year, does not expect to issue a report on its findings for another month. —**Washington staff**

Wilson Order Hampers Research Effort

Furnas' post abolished; research and development effort placed under engineer-economist Newbury.

By Claude Witze

Washington—Frank D. Newbury, 76-year-old retired engineer with a decided coolness toward research and development, won his four-year fight last week to control the Defense Department's R & D effort.

Departure from the Pentagon of Dr. Clifford C. Furnas, who left the post of Assistant Secretary for Research and Development to return to his job as chancellor of the University of Buffalo, gave Newbury his long-awaited opportunity.

Dr. Furnas' old job has been abolished, along with Newbury's original post as Assistant Secretary for Engineering. In their place, Defense Secretary Charles E. Wilson created an Assistant Secretary for Research and Engineering and named Newbury to the position.

One of the country's leading scientists familiar with the situation and Newbury's career at the Pentagon told AVIATION WEEK that "Mr. Wilson is getting ready to fight World War II better, not to fight World War III." This man said he was "flabbergasted" and that "the wrong office has been abolished."

Furnas Opposed Move

The shakeup creates a situation that Dr. Furnas struggled to avoid during his tenure. When he left his desk a few weeks ago, he reiterated his stand that the engineering aspects of new weapon development should be under control of the Assistant Secretary for Research and Development. He further suggested that Newbury's office be abolished and its duties shifted to a deputy of the Assistant Secretary for Research and Development (AW Feb. 18, p. 28).

Instead, Secretary Wilson, who also possesses a cool attitude toward research and development, promptly moved Newbury into the top post.

Less than a year ago, Dr. Furnas threatened to quit when Newbury was given jurisdiction over "technical aspects of development projects," taking this area away from the Assistant Secretary for Research and Development (AW March 5, 1956, p. 27). The order was withdrawn, and Dr. Furnas served out his promised 18 months of duty.

Emphasis on Engineering

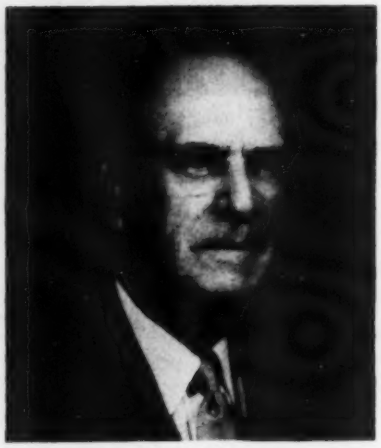
Before Dr. Furnas, Newbury's effort to exercise more control over weapons in the development stage was opposed by Donald A. Quarles, at that time Assistant Secretary for Research and Development and now Secretary of the Air Force.

The almost inevitable emphasis upon engineering that will come under Newbury's rule will be a source of increasing distress to the Defense Department's staff of about 100 professional scientists and technologists.

Anticipating their cool reaction, Wilson denied in his announcement of the change that the shift will cut down their contribution to the overall program. He also pointed out that the consolidation of the two offices was recommended by the Hoover Commission.

Actually, the scientists are not disturbed by the change in the table of organization.

They are upset by the inclusion of "engineering" in the new assistant secretary's title to the elimination of "development" and by the choice of Newbury to head the office. They fear the "nuts and bolts" approach will seriously cripple technological progress.



Frank D. Newbury

In his early Pentagon career, Newbury ran afoul of jet engine manufacturers with an attempt to establish stringent specifications for gas turbines, regulating size and thrust, and attempting to freeze them before possible development advances could be incorporated.

He is known to have opposed Boeing's KC-135 jet tanker program and blocked some early orders for the Martin P6M SeaMaster.

There was hope among scientists that Newbury's approach would be offset to some degree by appointment of William M. Holaday as his deputy. Holaday served for a year as assistant to Dr. Furnas and is credited with being a scientist as well as engineer.

Holaday is 20 years younger than Newbury and, unlike his boss, has worked in research and been associated with professional societies such as the Society of Automotive Engineers, Institute of Chemical Engineers, Society for Testing Materials and the Industrial Research Institute. He has been active in the National Advisory Committee for Aeronautics, specializing in aircraft fuels and powerplants.

Newbury's background is almost entirely that of the engineer, administrator and economist. He graduated from Cornell University in 1901 and spent his entire career with Westinghouse Electric Corp. In 45 years with that firm he rose to become a vice president and member of the board. His major experience was in the design of steam turbines, management and administration.

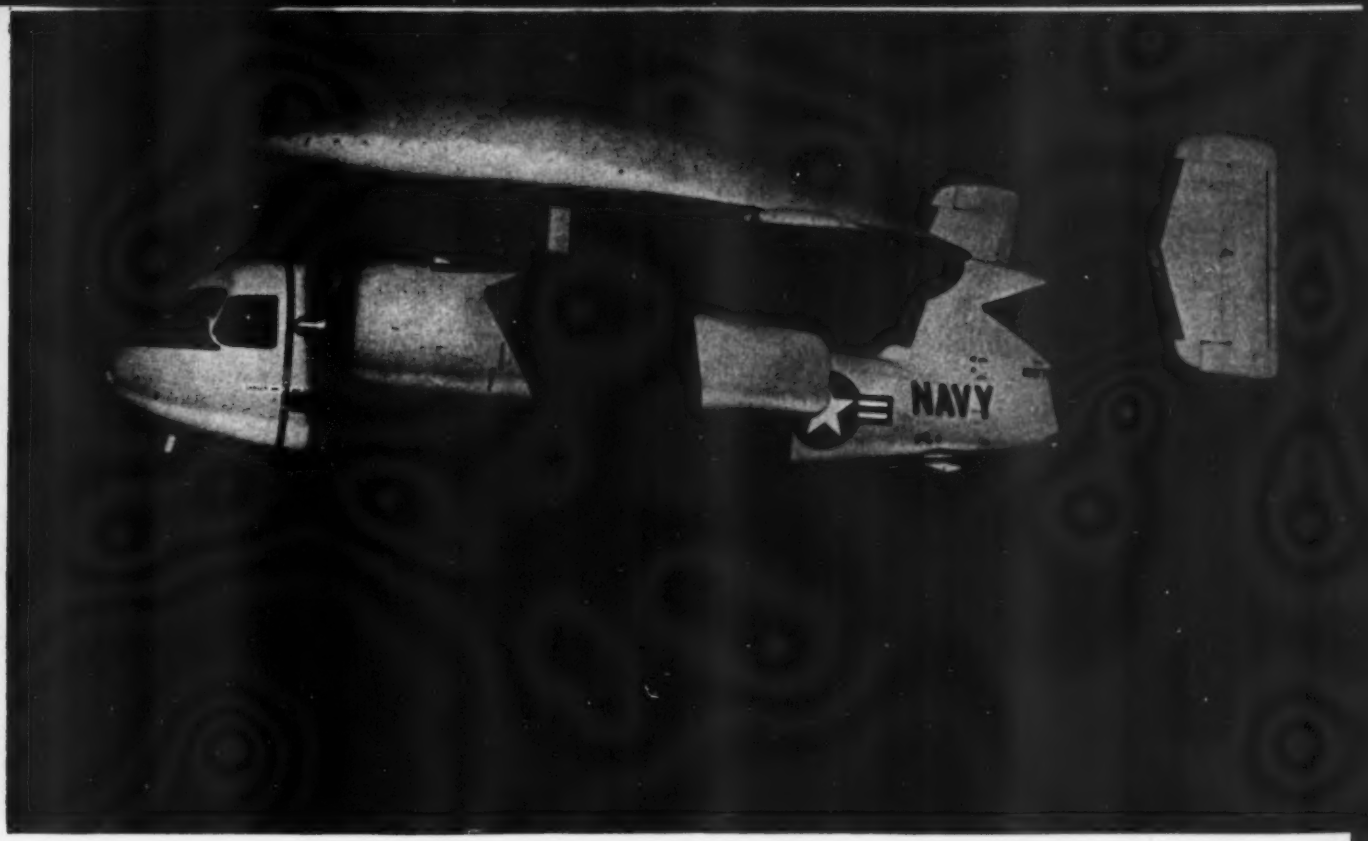
Why Newbury?

Washington—Defense Secretary Charles E. Wilson says he appointed Frank D. Newbury to the new post of Assistant Secretary for Research and Engineering because "he was competent to do the job and he was available."

Wilson also told a press conference that the new assistant secretary "has no authority to operate, as such." His job, the Pentagon boss declared, is to advise Wilson on what should be done, "and whether it is done or not is up to the secretary, and the services and the people that do it."

Newbury's big asset, according to Wilson, is in his administrative and executive ability. Wilson also maintains that the Defense Department has practically no research activity, that most of it is in the hands of contractors, laboratories and arsenals.

It is no secret that Newbury and Wilson hold similar views on the value of research to the defense effort. Secretary Wilson says he is not trying to "downgrade" research, but that he favors "directed research" as opposed to "pure research." He feels, and Newbury is in agreement, that defense funds should not be spent on research projects that do not appear vital to the defense effort.



Grumman Turns TF-1 into WF-2

Grumman WF-2, an early warning modification of the TF-1 Tracker, mounts .051 aluminum alloy skin radome above fuselage on prototype. Production version radome probably will be fiberglas honeycomb sandwich. Radome dictated complete redesign of tail to provide twin vertical fins at stabilizer tips. It also meant redesign of wing folding geometry because of interference of radome with folded outer panels. Other changes: wing midsection modification for additional fuel; 18-in. extension of fuselage forward cabin area to improve airplane balance; nose wheel strengthening; complete tail wheel redesign because WF-2 becomes tail wheel airplane with wings folded. WF-2 is a four man, five place airplane—two pilots, two operators. One pilot moves to tactical director's seat, otherwise unoccupied, during operations. Hazeltine Electronics Corp., Little Neck, N. Y., will provide radar equipment. Grumman submitted design Jan. 13, 1956, flew prototype in less than year.

Quarles Slows Bid for Boost in Budget

By Katherine Johnsen

Washington—Assurances by Air Force Secretary Donald A. Quarles that the U. S. is "substantially" ahead of the USSR in long-range strategic air capability—and will remain so under the administration's program—at least temporarily dampened moves in the Senate last week to boost USAF's proposed budget of $17.7 billion for Fiscal 1958.

Quarles told the Senate Armed Services Committee:

"While at one time Bisons appeared to lead B-52s in production, the present indications are that B-52s are substantially ahead in numbers as well as quality, and there is every prospect that they will remain so."

Fiscal '57 Boost

Last year, the Senate added $900 million to USAF's procurement budget to boost the B-52 program after testimony by Gen. Curtis LeMay, commander of the Strategic Air Command, that strategic air supremacy could pass from the U. S. to Russia during the 1958-60 period.

And despite Quarles re-calculation of Soviet strategic air strength last week, Sen. Richard Russell (D.-Ga.), chairman of Senate Armed Services Committee, said he still considers the $900 million addition a wise move. "It pressured the Defense Department to raise the goal," he said, "and get B-52s into an Air Force in being."

Russell said he "would like to see" the present production target of 20 B-52s monthly adhered to, "but I would not be too critical if it is not."

B-52 production, now running at approximately 12 a month, is tentatively scheduled to reach a maximum of 17 a month in about one year.

B-52 Program

The Air Force has programmed 603 B-52s, 502 from Fiscal 1957 and previously appropriated funds, and 101 from Fiscal 1958 funds.

Quarles suggested, however, that the program may be increased and said:

"Further production of the B-52 beyond the 603 requirement depends upon the progress of our first supersonic bomber—the B-58—which is a follow-on for the B-47 medium bomber.

"If it should prove necessary or desirable to delay the production of the B-58, we may apply a part of the funds earmarked for the B-58 to support a larger B-52 program."

After Quarles testimony, Russell said the new estimate of Russia's strategic air strength is "hazy" but added that last year's calculation was "also hazy."

He said his main concern with the USAF budget is the cutback in the nuclear aircraft program. There has been, he said, "a drastic reduction" in the program of a year ago, and "I am not very happy about it."

Sen. Stuart Symington (D.-Mo.) challenged Quarles' optimistic picture of USAF's Fiscal 1958 budget in a speech on the Senate floor. Specifically, he challenged the Secretary's claim that the Fiscal 1958 budget is "roughly $2.5 billion" above Fiscal 1957. The real increase, Symington said, is only $66 million.

Although President Eisenhower originally asked for only $16.5 billion for Fiscal 1957 as compared with $17,756 million for Fiscal 1958, Symington pointed out that the Fiscal 1957 budget was raised through congressional efforts to $17,690 million. This puts the 1957 budget to within $66 million of the proposed 1958 budget.

Quarles on R & D

Quarles said USAF's research and development program is "as strong as I believe it needs to be if we are to meet the Communist challenge to our qualitative position" and added:

"Inventory lead-time, which has come in for some criticism recently, is not in itself a good measure of the effectiveness of development effort. The real question is not how long it takes to do the job, but how good the job is in relation to the state of the art and, particularly, the state of the competitor's art when it reaches the operational stage.

"The eight years that we took to bring out the B-52 bomber in comparison with an alleged four or five years required by the Soviets for their Bison bomber is a good case in point. In the first place, I doubt that we know just what the comparable Soviet interval was.

In the second place, the facts are that the B-52 is a substantially more advanced and higher performance weapon system than the Bison. . . .

'Minor Consideration'

"It seems fair to conclude that the development interval, whether it is four years or eight years, is a minor rather than a major consideration. The important point is to be sure that the weapon system finally produced is at the forefront of the art."

Quarles maintained that the Fiscal 1958 program planned for USAF meets the major test: "To confront would-be aggressors with a retaliatory capability which they could neither destroy nor escape."

Meanwhile, in a speech indicative of the general budget-cutting trend in Congress, Rep. Thomas Curtis (R.-Mo.) charged that "a good bit of the Russian military buildup comes from our own military establishment's propaganda machine, which uses this theme to bolster its requests for appropriations."

He added:

"The military establishment is led by dedicated leaders who remember the twenties and early thirties when it was so starved that it could not carry out its basic function to defend our society against external forces. They are determined to see that this does not happen again. But, in doing this and pursuing their course and using the tactics they have used and are still using, they are hurting the ability of our country to meet the problems that face us in the world today. They are playing up Russia's game of bluff."

Pentagon Cuts Development Cycle

Washington—Pentagon has made progress in its one-year effort to shorten the concept-to-inventory cycle for military aircraft, according to Defense Secretary Charles E. Wilson.

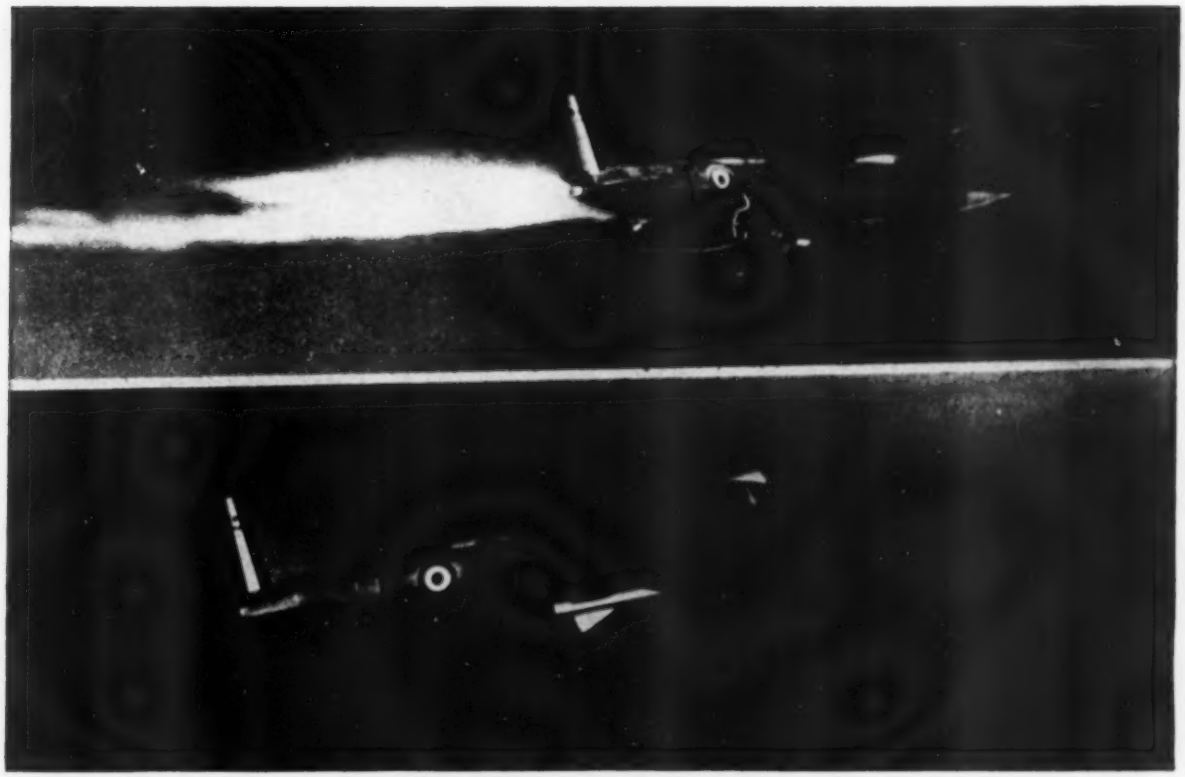
Wilson released a report on action taken by the Army, Navy and Air Force to carry out recommendations of the Manned Aircraft Study Group but still refused to remove the classification label from the group's report which was submitted to him last July 25. Informed sources say there is almost nothing of a classified nature in the document, but that it is being withheld because it "steps on a few toes."

The recommendations of the committee included a plea for placing more management responsibility in the hands of industry (AW Sept. 17, p. 26).

The Defense Secretary says consultations with industry leaders are under way, but his list of accomplishments since last summer includes no reference to the committee's decision that industry should have more freedom in filling its contracts.

This is what the Department of Defense says has been done to speed the cycle:

- **Establishment of more adequate** long-range planning groups to define weapon needs for each of the armed forces.
- **Steps to uncover sources** of ideas for new weapons and components, with emphasis upon the contributions of industry research and design experts.
- **Earlier and more continuous review**



Trident Carries New Missile

First flight pictures of French Trident II with armament layout show one of two rocket engines firing. Second plume appears to be exhaust from turbopumps from belly vent ahead of tail. Missile is a mockup of future air-to-air weapon. Trident was scheduled to use a French Matra type missile. Trident II, powered by two wingtip mounted Viper turbojets as well as two SEPR liquid propellant rockets, has reached Mach 1.9 in level flight at probable altitude of 40,000 ft. (AW Jan. 28, p. 33).

by secretarial and staff chief levels in each department of new weapons programs.

- **Appointment of senior,** experienced officers to act as managers of each new aircraft development program.
- **Duty tours of three to five years** for weapon system managers. Training programs have been instituted to prepare future program managers.
- **Reduction in the complexity** of contracting procedures, design specifications and reports required from industry, and earlier action to acquire long lead-time materials, tools and facilities.

USAF Progress

A report to Wilson from Reuben B. Robertson, Jr., Deputy Secretary of Defense who was chairman of the Aircraft Study Group, cites USAF progress during 1956 under the "System Requirement Release Procedure" initiated well over a year ago by the Air Research and Development Command.

Robertson said the program, designed to make industry cognizant of USAF's leading problems, has resulted in the creation of 148 study groups in 44 companies, each engaged in work that should speed the development cycle.

Douglas Fears Research Imbalance

Los Angeles—Balance between research and practical engineering may be losing out in the defense effort, Donald Douglas, president of the Douglas Aircraft Co., told the Los Angeles Council of Engineering Societies.

"At present," Douglas said, "under pressure of keeping pace with any potential enemy, large sums are being spent on "study contracts." We find a growing number of companies primarily engaged in this kind of activity. Is it possible that our government is overdoing the "study contract" business and thereby is helping create our much publicized engineer shortages?

"I think this channeling of too much engineering talent in such directions has an adverse effect, for example, on our ability to design, produce and develop quickly new and better aircraft. In our striving to find the ultimate weapon of tomorrow, we should not neglect the weapons of today for that is when we may need them.

"Now, before official eyebrows begin to rise and rebuttals begin, let me hasten to affirm my belief in the importance of research in its purest form. Obviously we must have it in order to acquire the basic knowledge upon which our engineering and production depend. We must have the research scientist and the practical engineer. My only concern is to keep the ratio in balance."

Douglas emphasized his views at this point by saying: ". . . And I think of late it has shown a tendency to swing somewhat out of balance."

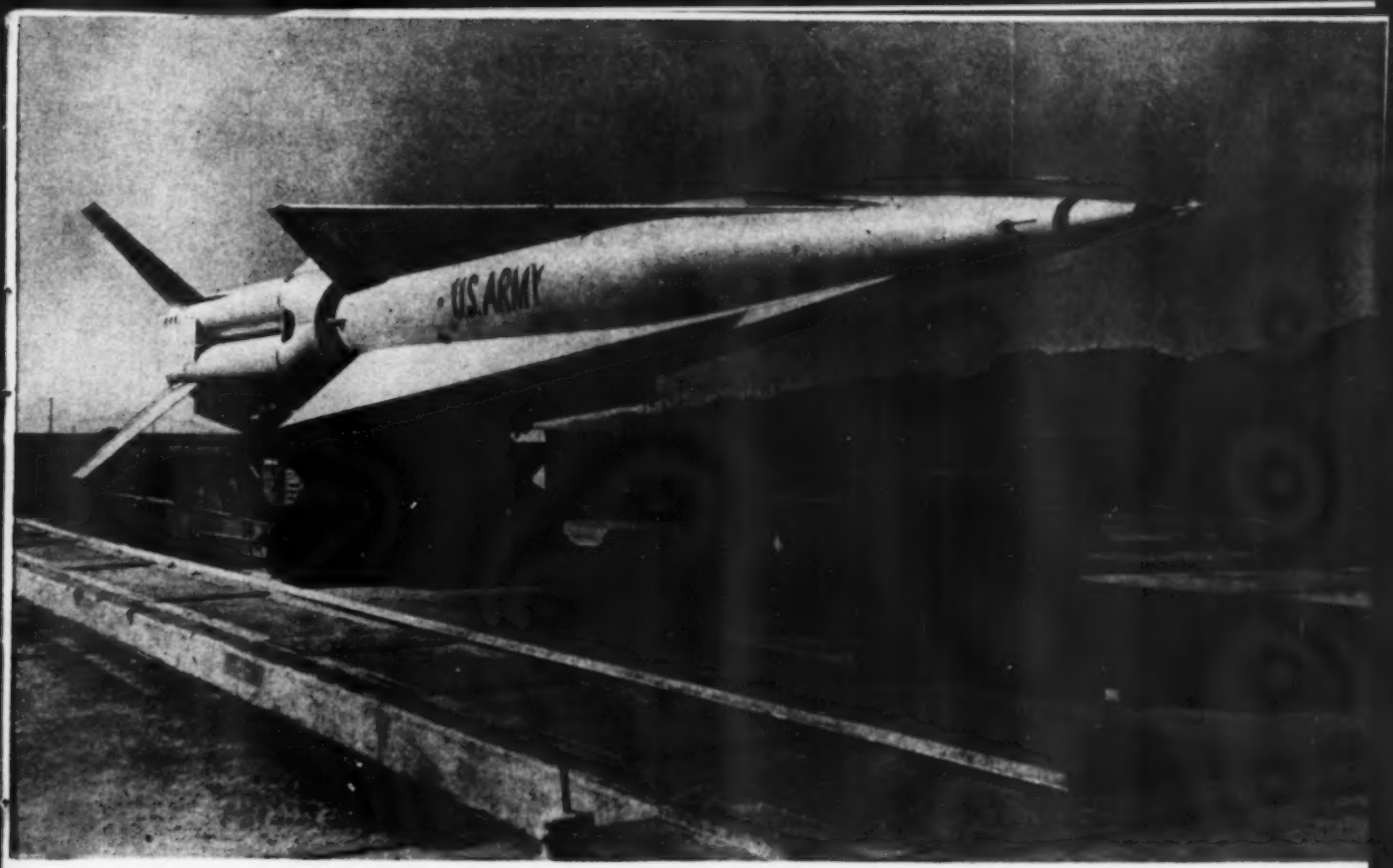
Douglas commented on the status of young engineers in the situation:

"Too often, I think, young engineers yield to the lure of these specialized companies and neglect their long-range interests. It is true that young men affiliating with such companies attain relatively high pay early in their careers. What actually has happened is that they have reached a plateau rather quickly and then often have no further heights to scale.

"By comparison, the young man who goes to work for a large, fully integrated company engaged in actual production has increased his prospects immeasurably."

Longer Range Nike Carries Atom Warhead

COMPARISON of Nike Ajax (above) and Hercules (left) in their launchers illustrates design changes which give later model greatly improved performance. Changes involve wing planform, control system, four-rocket tandem booster, and booster fins. Body length is increased and diameter is more than double Nike Ajax.

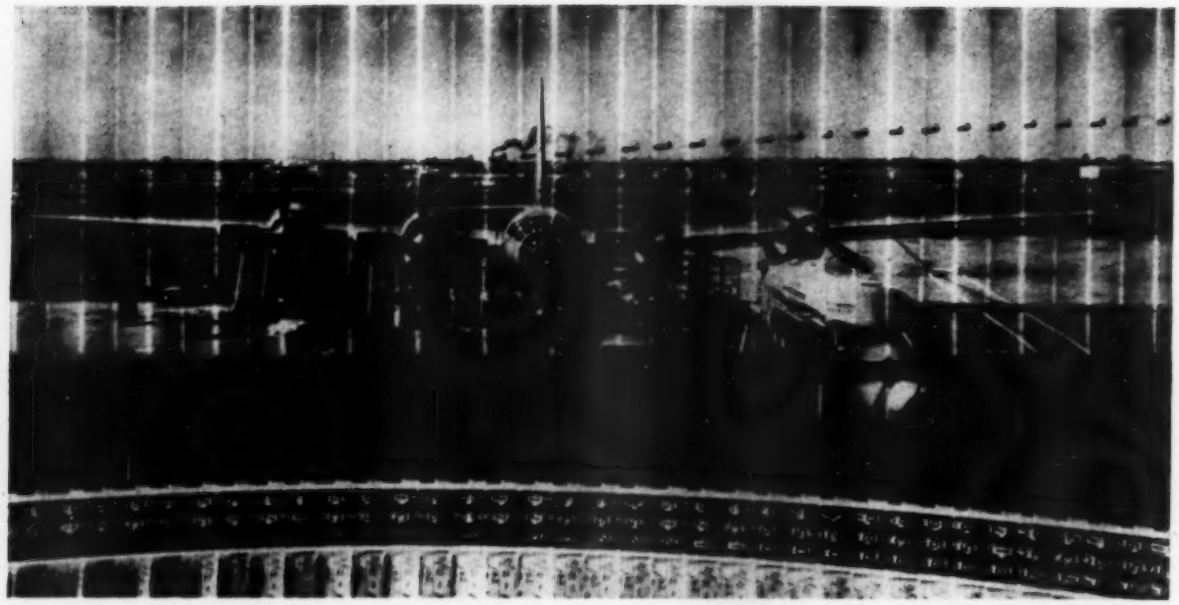


NIKE HERCULES, carrying a nuclear warhead with higher speed, altitude and range performance than its predecessor Nike Ajax, greatly increases the Army's anti-aircraft capability. The new missile shown on launcher (above) and during firing tests (below), is officially scheduled to become operational in the "relatively near future."

Its range of more than 50 mi., and improved altitude performance will enable established Nike batteries near targets to engage the most modern aircraft before they reach their bomb release points. This was not possible with Nike Ajax. The nuclear warhead makes each missile effective against a formation rather than a single plane.

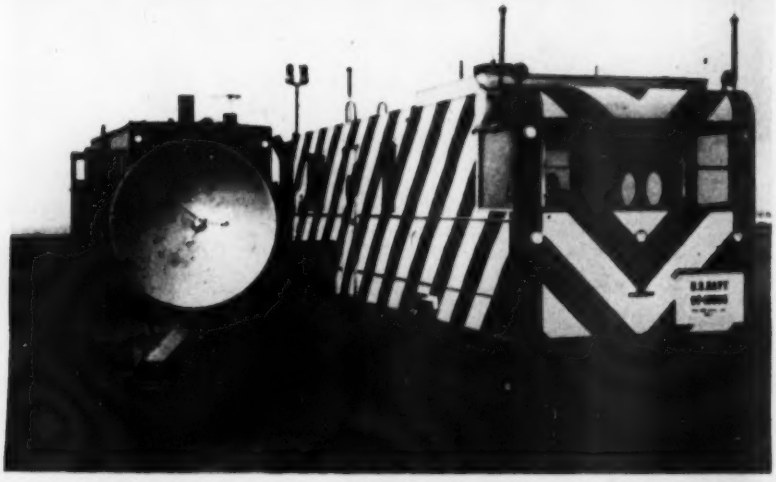
Existing Nike ground control equipment may be used with the Hercules after some modification, which also increases the effectiveness of Nike Ajax. Hercules wing planform indicates that its operating Mach number is substantially above the Ajax. Canard controls of the earlier missile have been replaced on the Hercules with fixed forward damping fins and movable surfaces on the wing trailing edges. Nike Hercules has extreme maneuverability at altitude. Maximum slant range of Nike Ajax during tests has been approximately 26 miles (AW June 4, 1956). Nike Ajax was Nike I; Nike Hercules was Nike B.

Western Electric Co. is prime contractor for Nike Hercules, and builds ground guidance and control equipment and missile guidance at its Burlington and Winston-Salem, N. C., plants. Douglas Aircraft Co. is producing the missile at Santa Monica, Calif.



SEQUENCE CAMERA TRACKS F3D as it lands (behind B-50) under control of Bell-developed Automatic Carrier Landing System.

Bell System Permits Hands-Off Landings



F3D NEARS TOUCHDOWN under control of ACLS, whose mobile units are shown in lower photo. Equipment, housed in van used for tests, actually occupies very small volume.

By Evert Clark

Buffalo, N. Y.—Bell Aircraft Corp. unveiled an automatic carrier landing system last week that allows hands-off landings in zero-zero weather.

Developed for Navy's Bureau of Ships and USAF's Air Research and Development Command, the system is easily applicable to any modern aircraft containing either an instrument landing system-autopilot or data link-autopilot combination.

Both the Air Force and Army have shown interest in its application to helicopters, and several missile manufacturers have indicated interest in the system's use for recoverable missiles.

More than 1,200 successful landings have been made since May 5, 1954, with a Douglas F3D, North American F-86 and B-25, a Cessna 310 and a Convair 340.

The Navy system will go aboard a carrier shortly for sea trials. The basic system passed acceptance tests in land-based trials at the Naval Air Test Station, Patuxent River, Md., in September, 1954. It passed Air Force acceptance tests at Rome Air Development Center, Griffis AFB, N. Y., shortly afterward.

Bell President Leston P. Faneuf termed the development of the system a "tremendous technical breakthrough."

Both the Civil Aeronautics Administration and Edward P. Curtis' Aviation Facilities Planning Group have followed development of the landing system.

Its simplicity and the ease of

adaption to existing commercial airliners give it a high potential for civil airline use, a Bell spokesman said.

The only addition necessary to prepare an airliner for use with the system is the addition of a corner radar reflector which folds up with the landing gear. An eight pound airspeed controller can be added, but Bell has found that pilots generally prefer to monitor their own airspeed on approach.

Both the pilot and the single human monitor who would oversee ground operation can override the system instantaneously. Automatic control of wave off in the event of a last-minute problem is a specification of the Navy system.

The carrier version will include a radar data stabilization unit which, in effect, will eliminate from the system the roll, pitch and yaw of the ship, compensating for the motion of the carrier's deck and allowing for even safer landings than those made by a pilot.

In the 1,200 test landings made thus far, Bell has found that the system can put a plane down within 10 ft. either way of the runway's centerline and within 22 ft. on either side of the desired landing spot for carrier-type landings. For flared landings of the type used by land-based aircraft, the figures are plus or minus 10 ft. and plus or minus 100 ft.

The system also works well with existing landing aids—including Tacan, ILS, GCA, Vortac, surveillance radar and low frequency range.

Basically, the system operates this way:

- **Radar positioned beside the runway** picks up the plane as it passes through a "window," or "gate," in space in line with the runway and two miles out in the case of carriers, or four miles out in the case of land-based planes.
- **Computer containing ideal roll,** pitch and yaw parameters for an approach and landing receives actual attitude data from the radar.
- **Using radio signals** sent to the plane's autopilot through data link or ILS, the computer sends out correcting data. The autopilot then flies the plane to touchdown. Control can be maintained for more than 100 ft. after touchdown if desired.

The system is an outgrowth of data link work carried on at Bell in the mid-1940s and in an attempt to develop an automatic system for dangerous flight test work—specifically, with the jet P-59.

In 1949 and 1950, Bell did data link development for Chance Vought's Regulus I missile. In 1950 and 1951, Navy's Bureau of Ships and the Air Force became interested.

A Navy development contract and an Air Force theoretical program resulted. The Air Force later dropped out so far as supporting funds were concerned but continued to watch development and, approximately two years ago, resumed a more active interest. Since then, it had decided to purchase a few test articles.

Bell credits the development of the landing system largely to John Chisholm, an electronics engineer who left Bell less than a month ago to form Sierra Research Corp., of Buffalo.

The group leader is now Harold Fletcher. Assistant group leader is Campbell Hills. Robert Theisen and Herb Mennen are project engineers.

Bell won a competition for the system from Minneapolis-Honeywell. It says much of its success is due to the fact that it has primarily stuck to standard equipment that was commercially available. Much of it, of course, has been modified.

Computer in the original system—which the company now considers no longer experimental but "ready for operational use—is a Reeves analog. Data link is Bell's own development. The autopilot is a greatly modified Bendix P-1 which was installed in the test plane when Bell acquired it.

Maintenance time on the landing system itself has been only ¼% of the maintenance time for all test equipment, including the aircraft.

Future systems will incorporate compensation for crosswinds. Since military requirements are for one landing every 30 seconds, two radars will be necessary in the system. One computer however, will handle the flights monitored by both radars. The radars will alternate, one handling a landing while the second picks up a second plane.

The size of the corner reflector for fighter type aircraft is eight inches. In the first test landing of the Cessna 310, a reflector was hand held in the cockpit. Much of the work going into the shipboard radar data stabilization unit is the outgrowth of four years of study by Bell of ship motion.

The carrier trials will begin by summer. Bell expects some refinements to result. The company says production could be accomplished within two years of the completion of these refinements.

Digital Computer Leads Analog In Weapon Control Use Trend

By Irving Stone

Los Angeles—Trend in weapon control is toward digital computer, because of its greater flexibility, higher accuracy, lower cost, better producibility, shorter lead-time and lower requirements for skilled manufacturing labor.

This trend was pointed out by James M. Bridges, director of electronics in the office of the Assistant Secretary of Defense-Engineering, at the 1957 Western Joint Computer Conference. It follows, he said, that cooperative effort of the military and industry must be aimed at the immediate goal of standardizing design of digital computer functional building blocks for weapons system application.

Change to digital computing techniques for weapon control is both desirable and inevitable, Bridges said. Because of the rapidly increasing complexity of weapons of all kinds, digital methods offer the greatest promise for solving the control problems, he declared. State of the electronic component art justifies the development of digital devices for all new weapon control programs, he said. In the future, analog weapon control will play a minor role in support of digital systems, Bridges believes.

"I doubt that it is fully appreciated in the weapon control field that the digital computer promises many advantages over the analog device in addition to its greater performance capabilities," Bridges declared. The digital computer has far greater flexibility than an analog device, hence a single basic computer design, with only minor modifications can be applied to the solution of a number of different weapon control problems, he said. This capability has very significant implications with regard to standardization of design, resulting in engineering effort economy, improved reliability and better production and logistics.

Bridges offered this comparison on an airborne digital computer now entering pilot production as a direct replacement for an analog computer in an existing bombing/navigation system: quantity production costs of this digital computer will be about 40-50% less than that of the analog. Capital equipment for production of the digital computer is expected to be reduced by 70%. Skilled manufacturing labor should be reduced by almost 70%. Lead time for new production is expected to be cut by 60-70%.

Bridges stressed reliability by cautioning that in entering the new field of digital technology, "We may not fully use the knowledge of weapons control systems engineering and equipment reliability which has been developing in the electronics and weapons system industry."

He explained that the relatively new field of digital computers had been

New RCA Radar For Missile Test

New York—Precision radar system, designated AN/FPS-16, has been developed by Radio Corporation of America to track guided missiles accurately over extended ranges in all-weather conditions and develop data that can be reduced rapidly to final form.

RCA's instrumentation radar is designed to track targets with or without beacon transponders and produce spherical coordinate data outputs of high accuracy.

AN/FPS-16 equipment, developed by RCA's Missile and Surface Radar Department, Moorestown, N. J., will be installed in a fixed station and housed in special enclosure. The radar pedestal is designed for tower mounting, detached from the enclosure to minimize transmission of vibration. The equipment was designed to a joint services specification under a consolidation of U. S. Navy BuAer and Army Signal Corps contracts under Navy cognizance and is now being produced for Air Force, Navy and Army test ranges.

built up primarily around requirements of the general purpose machine. As in any new and highly specialized branch of engineering, he declared, there is a tendency here that a tightly bound group of specialists may develop, speaking its own language and tending to some extent to break away from other branches of the electronics industry. This has the effect of decreasing the interchange of technical experience, a potentially serious deterrent to both reliability and systems performance of digital computers in weapon control systems, Bridges warned.

"We can waste a lot of time and engineering resources in this inevitable transition from analog to digital computing techniques if we do not make maximum and continued use of the weapon control know-how that has been built up in this country over the past quarter of a century," he said. "In this connection, it is interesting to note that a few organizations of many years experience in designing military control devices have entered the digital field during the past few years with outstandingly successful results.

"We can suffer even greater losses if the proven reliability concepts and techniques established through years of hard work and cooperative effort on the part of industry and the military departments are not applied to the fullest extent in this military digital computer field. . . ."

Bridges pointed out that he was convinced that, using present techniques and components we can design digital weapons system computers which will be more reliable than the best electronic equipment now in service.

One of the most promising techniques for obtaining reliability in digital computers appears to be the exploitation of their basic inherent flexibility to develop standardized designs of system building blocks, he declared. Basic geometry of many weapon control problems is quite similar and can be solved by proper system grouping of similar computer elements. Such a standardized design, Bridges declared, would make it unnecessary to develop a completely original computer for every new weapon system project and would permit the use of standard computer elements of proven reliability. This reliability could be brought to a very high level through extensive engineering, testing, re-engineering and continued production.

Doman Is President in Shakeup

Danbury, Conn.—Top management shakeup of Doman Helicopters, Inc., has been initiated by stockholders in an attempt to improve the company's survival factor.

Top casualty was President Donald S. B. Waters, replaced by Glidden S. Doman, former vice president-engineering. A new board was also formed, comprising Doman, G. F. Finley, vice president-secretary; L. R. Ripley, D. K. Phillips, C. G. Dodge and Stephen du Pont. One or two additional directors may be named later.

Immediate future plans of the company will include increased effort to obtain additional military research and development contracts, further subcontracting, and an attempt to break a current bottleneck on commercial production of the LZ-5. R&D contracts on both rotary and fixed-wing projects will be sought. A company spokesman told AVIATION WEEK that orders for commercial helicopters now under negotiation approximate the number needed to break-even on a production basis; the problem is to get customers to agree to stagger their deliveries in a sequence allowing economical manufacturing. Doman adds that it needs about 20 orders to break even on a production quantity.

The company is still actively seeking to sell the LZ-5 to the French government through its agent, Marcel Dassault. Big drawback on this venture, according to the company, is the engine installation. The French want installation of the domestic Artouste turbine rather than the present American Lycoming piston engine. Doman has worked out a new model specification around this engine to meet the French requirement.

Doman thus far has built only two YH-31s, the Army version of the LZ-5. One is undergoing further evaluation by the Army; the second was scheduled for delivery to Ft. Rucker, Ala., last week.

The Doman spokesman stated that the recent moves by its stockholders will have no effect on the Canadian company, Doman-Fleet Helicopters, Ft. Erie, Ont.

Aero Design 560-E Has 222-Mph. Speed

Bethany, Okla.—Successor to the Aero Commander 560-A light twin business plane, the 560-E with range increased to 1,625 mi. and top speed of 222 mph., is being put into production immediately here by Aero Design & Engineering Corp.

High aspect ratio wings, five feet longer than the 560-A's 44-ft. span are the most noticeable change on the new 560-E, which replaces the previous version on the production lines here. Gross weight is 6,500 lb., a 500-lb. increase.

Four production 560-Es are scheduled to be completed by June. Powered with 295 hp. Lycoming high compression engines, the 560-E will sell for $74,900. Aero Design will make a conversion kit available in six months to 560-A owners who wish to modernize their airplanes to 560-E configuration. The conversion will cost $26,660.

Supercharged Lycomings To Get Free Rework

Bethany, Okla.—Modernization program aimed at licking piston burnout problems on the supercharged Lycoming GSO480-type engine has been developed by Aero Design & Engineering, Lycoming and Bendix and will be made available at no cost to Aero Commander 680 owners.

The fix is the result of an extensive test program by the manufacturers to determine the cause of several engine failures (AW Jan. 21, p. 117).

Lycoming will supply necessary replacement parts for the engine, Aero Design will assume labor costs. Engine will be equipped with pistons coated to resist corrosion and intergranular activity; exhaust valves with Ni-chrome heads to resist corrosion will be fitted; the carburetors will be sent to Bendix for new vinyl-coated diaphragms and improved throttle shafts and bushings.

TRAIL BLAZING – Many frontiers of science have been charted by Northrop Aircraft engineers and scientists in seventeen years of research and development of manned and pilotless aircraft. Northrop Snark SM-62s, first intercontinental guided missiles to be disclosed by the U. S. Air Force, are now flying from the Florida coast over the USAF missile test range. Northrop's newest trail blazer is a supersonic trainer designed to help pilots master the complexities of tomorrow's combat aircraft. Other Northrop trail blazers include Scorpion F-89 interceptors; pilotless target aircraft and missiles from Northrop's subsidiary, Radioplane Company; ground support and armament equipment from the Anaheim Division; and, entirely new concepts of integrated weapon systems which are constantly being initiated to improve our national defense.

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MAP shows 6,957 nautical mile Copenhagen-Tokyo route over North Pole. SAS DC-7C flight requires 30 hr., one stop.

SAS Opens New Trade Route to Orient

Inauguration of Copenhagen-Tokyo service brings first crossing of North Pole by commercial planes.

By Richard Sweeney

Copenhagen—Scandinavian Airlines System opened a new trade route to the Orient last week with inauguration of its Copenhagen-Tokyo service via the North Pole. The SAS polar route, cutting 22 hours flying time from conventional air schedules between Europe and the Orient, is a major expansion of this airline's exploitation of Arctic air routes as new intercontinental trade routes.

Two DC-7C aircraft, dispatched from Copenhagen and Tokyo, met near the North Pole. It was the first crossing of the North Pole by commercial planes.

Shorter Route

The 30 hr., 6,957 nautical mile trip compares with 52 hr. required to travel SAS's 8,957 nautical mile route to Tokyo via Europe, the Middle East and Southeast Asia.

Aboard the eastbound inaugural "Global Express" liner were Prince Mikasa of Japan, youngest brother of the emperor, his wife, high Japanese government officials, and SAS executives. On the westbound aircraft were Prince Axel and Foreign Minister H. C. Hansen of Denmark, government officials of Denmark, Norway and Sweden, which pooled their national airlines in 1946 to create SAS. The eastbound plane departed Tokyo International Haneda Airport at 0913 Japan time, estimating 12 hr. en route for the 3,136 nautical miles to Anchorage, Alaska, the route's first scheduled refueling stop. Altitude en route was 19,500 ft. The flight started with brisk tail winds and reduced power to maintain schedule. A wind shift along the Aleutian chain yielded 30 mph. headwinds, resulting in an elapsed flight time of 12 hr. 12 min.

Anchorage Stop

Anchorage welcome ceremonies were well attended despite the local hour—midnight. While SAS only changes crews and refuels there, Anchorage citizens have asked Washington for passenger traffic rights for SAS, hoping tourists will use the daily nonstop Seattle-Anchorage flight, stay over in Alaska, then continue to Europe or the Orient.

Anchorage ground time approximated 1¼ hr. No heating units were used for aircraft or engines and SAS has found that standard ground handling equipment should be adequate for all expected circumstances. Takeoff weight from Anchorage was 141,418 lb., well under the maximum allowable takeoff gross of 142,968 lb. Anchorage departure was at 0415 local or 1415 Greenwich time. Due over the Pole at 2130 GMT, the plane met continued headwinds and revised the estimate to 2145 GMT as arrival time. Actual arrival at the pole was 2147 GMT, slightly behind the westbound plane. Continuous adverse winds ranging from 30 to 70 mph. forced the eastbound plane to draw more power to hold schedule. This resulted in an unplanned landing at Oslo for fuel, with plane Capt. G. Lind observing the SAS fuel regulation specifying 7% route reserve plus 2 hr. holding fuel on arrival at destination. Elapsed time, Anchorage to Oslo, was 16 hr. 46 min. for 3,500 nautical miles.

Alternate Tracks

Although the inaugural flights both followed tracks carrying them over the geographic pole, SAS has a set of flight paths for the Anchorage-Copenhagen segment. One major course passes over the pole, the other bypasses the pole slightly on the Greenland side. In addition, five or six sub tracks are available for alternate airports in Norway and Alaska. Taking aboard fuel required by

regulations, the aircraft departed Oslo at 0736 GMT, arriving in Copenhagen at 0836 GMT (0936 local time) one hour later than planned for welcoming ceremonies at Kastrup Airport. Total flight time was 30 hr. 7 min., Tokyo to Copenhagen.

En route food service was scheduled according to Japan time, since passengers were accustomed to eating at these hours. Result was that in the polar region, where time changes swiftly, breakfast was served at midnight, local time, lunch at 6 A.M. local time, both in total darkness.

World Flight

From Tokyo the westbound flight was to continue around the world via SAS Southeast Asia-Europe route, arriving back in Copenhagen in 80 hr. Inauguration of the polar route followed 16 exploratory flights over the polar area proper and more than two years operational experience in Arctic flying for SAS on its Los Angeles-Copenhagen route via Winnipeg and Greenland. Service on the older run was inaugurated with DC-6Bs with a normal range of 3,000 mi.

Start of the Pole proper route awaited delivery of DC-7C aircraft with a normal range of 5,000 mi. In addition, SAS used the DC-7Cs on its North Atlantic run from Copenhagen to New York, and the Copenhagen-Los Angeles Arctic route to get a line on cold weather operations with the aircraft, which uses Wright R-3350-EA1 Turbo Compound engines and different Hamilton Standard propellers than do domestic DC-7s and DC-7Bs. Cold weather operations showed the line a number of problems which resulted in several modifications to the SAS DC-7Cs at the Douglas factory for polar flying.

Included were special insulation for all water lines and tanks for the chemical toilets to prevent freezing, use of plastic tubing in some locations so that possible freezing would not rupture lines. Another fix the line found necessary was on the propellers. Prolonged cold soaks during flight at average temperatures of −40C resulted in congealed oil in the propeller hub dome, turning the props into fixed pitch. Solution was incorporation of a second bleed hole and relief valve admitting warm engine oil to the dome.

Not yet incorporated but due for pilot installation for test is dome heating element which will keep the oil fluid should both bleed holes become plugged or clogged.

A second propeller problem was in the governor, where dissimilar metals had been used in moving parts. Use of metals with the same coefficient of expansion and contraction rectified this and in addition the governors were readjusted for extended low temperature operations.

Another situation under close scrutiny by SAS is the blade pitch lock used on this model propeller. SAS feels it is possible that the very small difference in blade angle between normal 2,900 rpm. for takeoff and the setting of 3,200 rpm., where the pitch is supposed to engage to prevent a runaway engine, may result in the blades going into fixed pitch at takeoff. Present SAS inflight procedure calls for taking the propellers from their cruise condition of being slaved to either No. 2 or No. 3 engine to independent operation, and reducing manifold pressure enough on each engine to produce a drop in rpm. should the prop be in fixed pitch. Since readjustment of the governor, change of metals to compatibility in the governor and installation of the second bleed hole and check valve, SAS has had no problems in these specific areas.

In its Arctic flight experience, SAS has found that the improved cooling on DC-7C engines with the longer prop spinners will drop cylinder head temperatures close to the minimum indicated on instrument dials—100C. However, prolonged flight at 110C for front and 120C for back side of cylinder heads has produced no unusual results so far.

The temperatures occur at cruise power long range mixture setting and cowl flaps full closed.

Grid Lines

Another feature of the EA1 engines is the elimination of carburetor icing problems by use of fuel injection.

Realizing most of the world's profitable air routes were well covered, SAS early in its history sought a route it might pioneer where it could establish itself as the leader in the public mind before competition became too heavy. Arctic routes to the U.S. West Coast and the Orient seemed feasible if the three main obstacles to polar navigation—a proper chart, accurate and reliable steering guide and a device to pinpoint position when celestial sights were impossible—could be overcome.

SAS solved its chart problem by adopting a system of grid lines which could be superimposed on map projections used in navigating the polar area, the Arctic regions and the lower latitudes of the North Atlantic run. The grid system is the same as that used by USAF in its polar flight operations. Using the grid system, the polar navigator sets up his course according to grid direction, which results in a great circle route over the ground.

Since the magnetic compass is unusable in the areas it planned to pioneer, SAS asked Bendix to develop a gyro with random drift of less than 2 deg./hr. Bendix came up with the Polar Path Gyro, which has satisfactorily proved in service it can hold random drift within the required tolerances. Polar Path is interconnected with the autopilot to provide automatic course direction during the grid flight. Polar Path readings can be made by pilots on the RMI dial by turning a switch, but the course reading is grid direction rather than a standard oriented direction.

Refining the Polar Path, SAS asked Bendix to develop an electronic unit which would compensate for gyro precession due to latitude. This was provided with the average latitude precession manually set into the system.

Kollsman Instrument Co. provided SAS with the Kollsman Sky Compass which utilizes the polarization characteristics of reflected light to give the navigator accurate position. It takes readings on the sun when it stays below the horizon each April and September in the Arctic, yet lights the sky too much for ordinary sextant star fixes.

SAS navigators who practiced grid navigation learned that high order course accuracy with Polar Path necessitated keeping a graph on random precession by half hour positions checks, although the units held within the specified 2 deg./hr. tolerance.

Kollsman Sky Compass familiarization also was accomplished. SAS then inaugurated the Los Angeles-Copenhagen route via the Arctic, with stops at Stromfjord on Greenland and Winnipeg, Canada, using DC-6Bs.

Since start of Arctic operations SAS has received an automatic latitude integration unit for Polar Path from Bendix. With this unit, which operates while the aircraft is under directional control by Polar Path, the navigator merely turns a knob until the proper latitude reading appears on the dial stop. The unit takes care of the necessary corrections, including sending correction signals to the autopilot.

Radio and Gyro

On the eastbound inaugural DC-7, combination of radio and gyro directional control was used in the northern area. When the plane left Anchorage, the autopilot was put on DC-7 beam guidance with the VOR tuned to Fairbanks omnirange. When the plane was nearing the limit of Fairbanks range outbound, the navigator established a grid course which would take the aircraft into Copenhagen, oriented his Polar Path gyro to this, and switched control from beam to gyro without the pilot having to resume manual control of the aircraft.

In many cases navigators will orient Polar Path gyros with respect to the takeoff runway when about to enter areas where Polar Path direction con-

Vickers Delivers 60th Viscount to Capital

Final Viscount of original Capital Airlines order of 60 undergoes pre-delivery flight test by Vickers Armstrong. Sixtieth Capital Viscount is first to be equipped with storm-warning radar. Original schedule called for delivery of the last Viscount by the end of this month. Tests were completed in mid-February, ahead of schedule. Last July the airline ordered an additional 15 of the turboprop airliners, with delivery to be completed by August, 1957. Total value of Capital's orders is $83 million.

trol is indicated. SAS currently has Bendix X-band, Collins C-band and RCA airborne radar sets undergoing route flying tests in DC-7Cs. Also aboard are AVQ-9 sets. Possibility of using AVQ-9 combined with X-band in the contour mapping configuration is under investigation as one means of a low order dead reckoning check on ground speed and drift. However, a navigational aid independent of cloud conditions (polar temperature inversions have been known to produce clouds up to 20,000 ft. occasionally) and free of atmospheric influence with first order reliability still is needed. Normal polar flying weather is excellent above 10,000 ft., SAS has found.

Usually high pressure covers the Pole. The air is low in humidity and winds are low in velocity and fairly dependable. Usual prevailing temperatures at flight altitudes between 12,000 and 20,000 ft. range between −30C and −50C.

To keep in contact with its planes at all points along the polar routes, SAS has built a number of 2½ kw. high frequency stations. Stations are at Andenes on the north tip of Norway, Isfjord on Spitzbergen, Nord and Dundas on Greenland, Resolute Bay on Cornwallis Island north of Canada and Point Barrow, Alaska, for the Scandinavian-Orient route. Other stations which SAS helped open include Angmagssalik and Soendestrom on the southern half of Greenland and Frobisher Bay, Churchill and Winnipeg in Canada for the Arctic run to Los Angeles.

Sharing in the stations with SAS were Norwegian, Danish and Canadian governments and Wein Alaska Airlines.

Ground wave transmitters which have a range of 700 mi. and cannot be blacked out by atmospheric disturbances caused by sun spots are located at Andenes, Isfjord, Dundas and Point Barrow. Using these stations plus a teletype circuit from Alaska to Copenhagen via New York, the polar flights should never be out of contact with headquarters in Copenhagen. Although intended primarily for weather and other voice data transmission to polar flights, the stations can be used to limited extent for radio fixes under certain conditions.

Despite the far north track, SAS will never be more than 2½ hr. flying time from at least one of more than 30 USAF and RCAF military airfields which dot the northern coast from Alaska to Greenland. Although the bases are secret, dire emergency landings can be effected, SAS says. In addition, should a crippled aircraft be unable to reach a base, the military has an excellent rescue service in the Arctic regions.

New F-27 Order

Hagerstown, Md.—An order for three Fairchild F-27 turboprop transports was announced last week by Southwest Airways. Delivery is scheduled for mid-1958.

The Southwest order brings total sales of the F-27 Friendship to more than 60. Southwest, with headquarters in San Francisco, now operates 10 DC-3s and seven Martin 202s.

Further precautions include carrying a sleeping bag for every person aboard a polar airplane. SAS crews have been through Arctic survival training with USAF, RCAF and Scandinavian forces. Present traffic projections indicate that if the new route carries 10,000 passengers between Scandinavia and Tokyo during the first year the route will be doing well. Presently slated are four flights weekly, two in each direction. Insofar as weight permits, cargo will be carried.

Airplane interiors are flexible but present plans call for 48 passengers aboard the mixed first and tourist class airplanes and 60 aboard the all-tourist flights.

Although SAS says no serious efforts have been made to obtain landing rights in Russian territory, the line has figured that a Scandinavian-Tokyo flight with one stop at Igarko in western Siberia would be only about 4,348 nautical miles and 17 hr. flight time. Whether or not SAS will pursue the matter when and if Aeroflot, the Russian airline, joins IATA remains to be seen. SAS presently has a route into Russia, but can operate only Saab Scandia unpressurized transports which are no better than Aeroflot's Ilyushins. Whether Russian introduction of Tu-104 jet transports on the run to Peking will give SAS a better chance to get the landing rights with its piston DC-7Cs also remains to be seen. SAS has ordered Douglas DC-8 jet transports and with these the present polar routes will be reduced to 17 hr. flying time. SAS has not yet announced other routes where DC-8s will be used outside the polar flights.

Military Details Future Navigation Needs

By L. L. Doty

Washington—Common air navigation system that can control and identify missiles and aircraft traveling at speeds of up to 2,800 kt. will be a military requirement by 1964.

In a paper presented to the Navigation Panel of the Air Coordinating Committee, USAF has outlined in broad concept the joint military needs for an air traffic control system that will permit an easy transition from air combat operations to a common navigation system.

The paper specifies the joint requirements of the Army, Navy, Coast Guard and Air Force. It does not include recommendations for technical implementation of the system.

What USAF Wants

Essentially, the Air Force wants an air traffic control system that will handle aircraft with these characteristics:

- **Operating speeds** between a hovering rate and 2,800 kt.
- **Altitude ranges** between a minimum height above the ground and 100,000 ft.
- **Capability of changing altitudes** at rates as high as 100,000 fpm.
- **Takeoff and landing speeds** that vary between 40 and 200 kt. and requiring airports capable of handling vertical takeoff aircraft and those using runways up to 10,000-ft. in length.

The system should provide navigation service to an "unlimited" number of aircraft at all altitudes, according to the paper. In terminal areas, the Air Force wants an air traffic control system that will handle landing aircraft of mixed types at a rate of two per minute for each runway in use.

The paper also calls for a positive means of identifying all aircraft in the terminal area without the need for any maneuvering. The system, it added, should include a means whereby controllers can visualize in three dimensions all traffic within the terminal area to a distance of 200 nautical miles and up to 100,000 ft.

The Air Force wants a simple display system for pilots that will give heading, altitude and speed to be flown in the terminal area.

In en route traffic control, the Air Force asks for an adequate number of air-to-ground communications channels to prevent delays in the transmission of position reports. A coded data link is suggested as a means of achieving this requirement.

The paper calls for direct pilot-controller communications within the jurisdiction of the air route traffic control center. Clearances, it says, must be automatically reproduced in the cockpit with continuous display of the information on the instrument panel.

Positive control of all traffic "whenever traffic densities and flight safety so dictate" is urged in the report. When necessary, parallel flight paths should be used, and the system should permit control of aircraft on any desired flight path within the navigational capability of the aircraft.

The paper urges rejection of flight clearances that are beyond the capacity of the system or conflict with others. It describes a need for automatic monitoring and control of clearances.

The report says the navigation system should include long-range elements that are operational up to distances of 2,500 nautical miles and should be sufficiently accurate to permit a protective block of airspace of one mile around aircraft in terminal areas increasing to five miles at the maximum 2,500 nautical mile range.

The system also should permit vertical spacing of aircraft at 500-ft. levels below 20,000 ft., and 1,000-ft. levels above that altitude. Changes in operating frequencies by the pilot should be required no more often than once every half hour.

Modification of airport design criteria was termed essential to assure rapid clearing of runways.

The Air Force also wants sufficient taxi strips to facilitate the flow of surface traffic and a better system of handling such traffic under all weather conditions.

Specific Requirements

The system should be available for full operation by 1964, the paper says. As research and development is undertaken for the program, the Air Force asked for these specific requirements as part of the system:

- **Size and weight of transmitters,** receivers and electronic equipment must be designed to fit military aircraft without decreasing performance.
- **Radiating devices** must be designed so as to deny their use by enemy aircraft but still provide service for friendly aircraft. The Air Force stated: "This dictates that compromises of the system's security must be easily correctable after short periods, and after correction, full security must be in full force again."
- **Simplified maintenance requirements** for both airborne and ground equipment. The Air Force suggested as "highly desirable" the "go-no-go" testing system and plug-in replacement of parts.
- **Systems and procedures** used in air traffic control must not prevent an aircraft from operating at maximum performance.
- **Ground components** should be easily adaptable to mobile units.
- **Traffic control** system must be designed to permit integration with the Air Defense System, Tactical Air Control System and other tactical means of controlling air traffic. It should have the capability of handling such tactical missions as air defense and search and rescue. The system also should be able to accommodate air traffic moving from an aircraft carrier to a point within the control of the common system.

Coach, Cargo Traffic Lead Airline Growth

Washington—Coach passengers and cargo led the way in the growth of U.S. certificated air carriers during the 10 year period from 1946 through 1955.

The Civil Aeronautics Board report that cargo ton-miles carried in scheduled service climbed from 54 million in 1946 to more than 434 million in 1955 for an increase of 708.7%. Coach passenger-miles in 1948, the first year of such service, amounted to approximately 5 million miles. By the end of 1955, the figure had climbed to 9.5 billion for an increase of 800.4%.

Other percentage growth figures:

- **Revenue ton-miles** for all services increased from 788 million in 1946 to more than three billion ton-miles in 1955, an increase of 290.4%.
- **Revenue passenger-miles** climbed from more than 7 billion to over 24 billion, an increase of 245.4%.
- **Total operating revenues,** including both service mail pay and subsidy, increased from almost $463 million to more than $1.5 billion, an increase of 254.1%.
- **First-class** revenue passenger-miles reached 7 billion in 1946 and almost 15 billion in 1955, an increase of 110.5%.
- **U.S. mail ton-miles** increased from more than 39 million to over 142 million, an increase of 264.3%.
- **Unduplicated route-miles** operated increased from 120,400 to 192,997, an increase of 60.3%.
- **Number of aircraft in service** with certificated carriers increased from 821 to 1,448, an increase of 76.4%.
- **Investment in flight equipment** climbed from almost $106 million to more than $543 million, an increase of 413.5%.
- **Number of persons employed** by U.S. air carriers grew from 96,554 in 1946 to 126,970 in 1955, an increase of 31.5%.

First Comet '3½' Rolls Out

First picture of the roll out of the de Havilland Comet "3½," prototype of the Comet 4, shows the aircraft at Hatfield Airdrome, Hertfordshire, England. Powered by Rolls-Royce RA.29 turbojet engines, the aircraft will be used in preliminary flight trials on test cargo runs between London and Rome by British Overseas Airways Corp. BOAC has 19 Comet 4s on order for delivery beginning in late 1958. In the U. S., Capital Airlines expects to introduce Comet 4 service in early 1959. The airline has four Comet 4s and 10 Comet 4As on order. The aircraft has made its first flight last week. Test Pilot John Cunningham said the improved control system handles differently than the earlier Comets, but he said the 2¼ hr. maiden flight was "satisfactory in every respect."

Capital Reports Net 1956 Loss Of $1.8 Million After Plane Sales

Washington—Capital Airlines last week reported an operating loss of $2,864,000 during 1956 and a net loss of $1,795,000.

In announcing the year-end results, Capital President J. H. Carmichael attributed the loss to costs involved in the introduction of the expanded fleet of Vickers Viscount turboprop transports and of "developmental mileage as a result of recent route adjustments."

The net loss reported was the balance after the inclusion of a special income of $2,455,000 from the sale of piston engine aircraft. This compares with an adjusted net profit of $4,562,276 in 1955, including a special income of $4,595,591 earned primarily from the sale of aircraft. The airline reported an operating profit of $325,341 in 1955.

Gross Revenues

Gross revenues for the year climbed 25% to an all-time high of $63.7 million from $50.8 million in 1955. Expenses rose from $50.3 million in 1955 to $66.5 million last year.

The airline added 46 Viscounts to its fleet during 1956 to bring the number of turboprops in operation to 57.

Non-stop New York-Chicago service was inaugurated during the year and flights between the two points via Buffalo were introduced as the result of Civil Aeronautics Board route awards late in 1955.

Service on the airline's southern routes was expanded following the lifting of certain operating restrictions by the CAB.

Management Promotions

Capital announced 11 management-level promotions as a major step in its over-all expansion program.

They are:

- **Hayes Dever,** named executive assistant to the president and secretary from secretary and director of public relations.
- **Waller Smith,** appointed assistant secretary of the company from manager of insurance.
- **Jennings Randolph,** named assistant to the president and director of public relations. Previous title was assistant to the president.
- **Nelson B. Fry,** appointed assistant vice president of traffic and **George Wertenbaker** director of sales. Both previously held the title of assistant to the vice president-traffic and sales.
- **Joel Daniels,** promoted to assistant vice president-advertising from director of advertising. **James W. Austin** will continue to head the department as vice president-traffic and sales.
- **R. W. Hardesty,** named assistant vice president-operations from operations manager.
- **Earl Raymond,** appointed director of maintenance from maintenance manager.
- **Stuart B. Goldthorpe** named comptroller and assistant vice president-treasurer from assistant comptroller.
- **S. T. McAlister,** appointed assistant vice president of properties under **Robert Wilson,** vice president personnel and properties.
- **R. M. Averill,** named director of personnel from executive assistant to the president.

Canadian Pacific Wins Montreal-Lisbon Route

Ottawa—Canadian Pacific Airlines plans service to Lisbon in June and to Madrid later under new authority granted last week by the Canadian government. CPA will use DC-6Bs initially on the route and probably Britannias at a later date.

Ministry of Transport's action in granting the new route may eliminate an election issue faced by the government, that of lack of competition on routes now flown by government-owned Trans Canada Airlines.

U.S. diplomats in Canada had expected the action (AW Feb. 25, p. 158), but it came sooner than expected.

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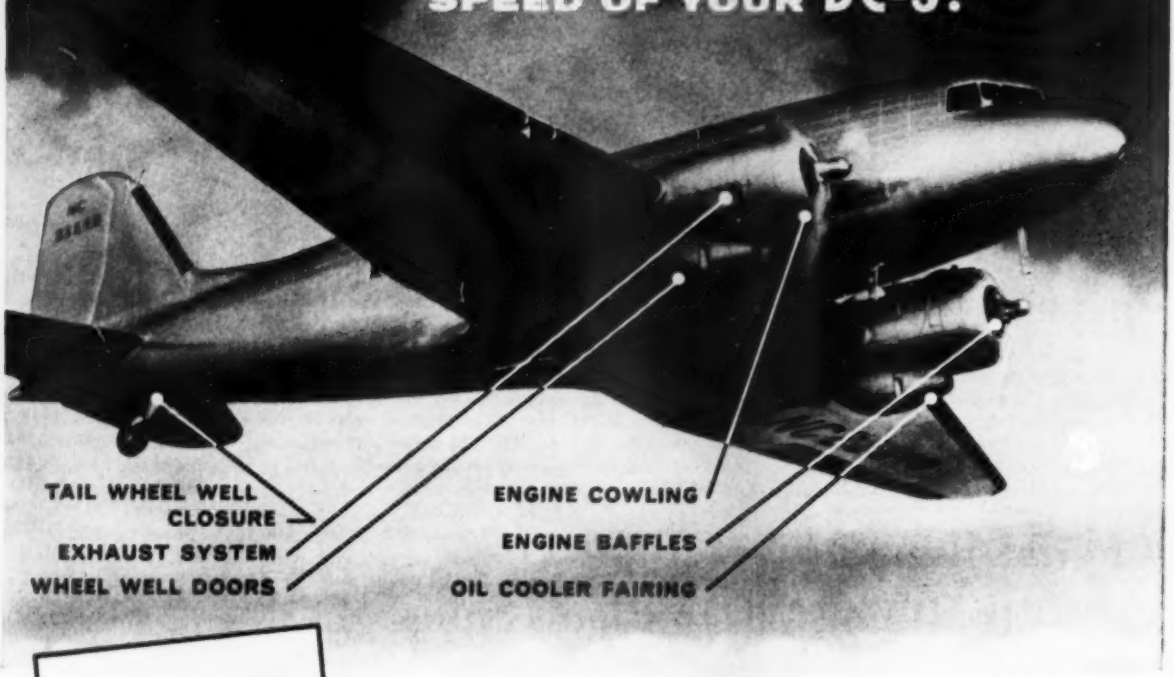

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Eastern Plans Idlewild Terminal

Passenger terminal planned by Eastern Air Lines at New York International Airport is shown in rendering above. Carrier in 1955 leased 23-acre site in Port of New York Authority's "Terminal City" at Idlewild. Other airlines which have leased sites for individual terminals at the airport are United, American and Pan American. Eastern's site can accommodate 16-gate terminal.

Pacific Case Enters Final Phase; PanAm, Northwest Argue Routes

Washington—Long standing dispute between Pan American World Airways and Northwest Orient Airlines over operating rights across the Pacific is nearing a climax.

Oral arguments in two separate, but economically related, cases have been presented to the Civil Aeronautics Board.

Two issues are at stake in the current proceedings. In the re-opened Transpacific Renewal Case, Pan American is seeking authority to fly the Great Circle route from California to Tokyo with traffic rights at Portland and Seattle.

The route from Seattle and Portland to Tokyo is now operated by Northwest under a temporary certificate. The second case involves Northwest's application for a permanent certificate on its Orient route.

Examiner's Recommendations

Both the Board counsel and examiner have recommended that Pan American be granted authority to use the Great Circle route but without traffic rights at Seattle and Portland. They also recommended that Northwest be granted a permanent certificate on its Orient route.

The issues were originally decided by the CAB in the Transpacific Renewal Case of 1954. At that time, the Board recommended that Pan American's application to use the Great Circle route be denied and that Northwest's authority be made permanent.

President Eisenhower, however, asked the CAB to revise its orders and extend Northwest's temporary certificate for a period of seven years. He withheld a decision on Pan American's application until early 1956 when it was returned to the Board for a report on new developments.

The Board first ordered that the re-opened hearing on Pan American's application and Northwest's application for a permanent certificate be consolidated. It later reversed itself at the request of the White House and set both cases for separate hearings. Presumably, its recommendations in both cases will be sent to the White House simultaneously.

'Full Competition'

Throughout the case and during oral arguments, Pan American has urged that it be allowed to operate over the Great Circle route to provide "full and fair competition" between the U.S. and the Orient.

Henry J. Friendly, Pan American vice president and general counsel, said the airline's present route to Tokyo over the central Pacific is circuitous and places Pan American at a competitive disadvantage and inconveniences its passengers. Northwest's attorney, William C. Burt, contended, in turn, that Pan American already carries the bulk of traffic over the Central Pacific and that, if Pan American receives authority to also operate over the North Pacific, it would place Northwest back on subsidy.

Representing Northwest in the Permanent Certification Case, Attorney C. Edward Leasure argued that the airline was denied permanent operating rights by the President because "Northwest was presumed to require subsidy for its international operations. However, it later developed that Northwest has conducted its international operations without subsidy since Jan. 1, 1955, and, therefore, is entitled to a permanent certificate."

Permanent Rights

Friendly said Pan American would not oppose a permanent certificate for Northwest providing Pan American also receives permanent operating rights over the Great Circle route.

The controversy over Transpacific routes began in 1946 when the CAB extended Pan American from Hawaii to Tokyo and granted Northwest authority to operate over the Great Circle route, both on a temporary basis.

Air Travel Increase Of 12-17% Forecast

Ithaca, N. Y.—U. S. air travel will reach 64.5 billion passenger-miles in 1965, according to Dr. T. P. Wright, president of Cornell Aeronautical Laboratory.

Domestic traffic will increase 12% yearly through 1960 and another 13% yearly through 1965, he forecast. U. S. international air travel during the periods will rise 15% and 17%, and world air travel will increase 13% and 17%, the former Civil Aeronautics Administrator said.

In his lecture to Cornell's Graduate School of Aeronautical Engineering, Dr. Wright also foresaw the real possibility of 1,500 mph. airliners, ramjet and nuclear commercial powerplants, all by 1975.

He predicted a need for vertical take-off service to cities, separate airports for various types of traffic and specialized cargo aircraft.

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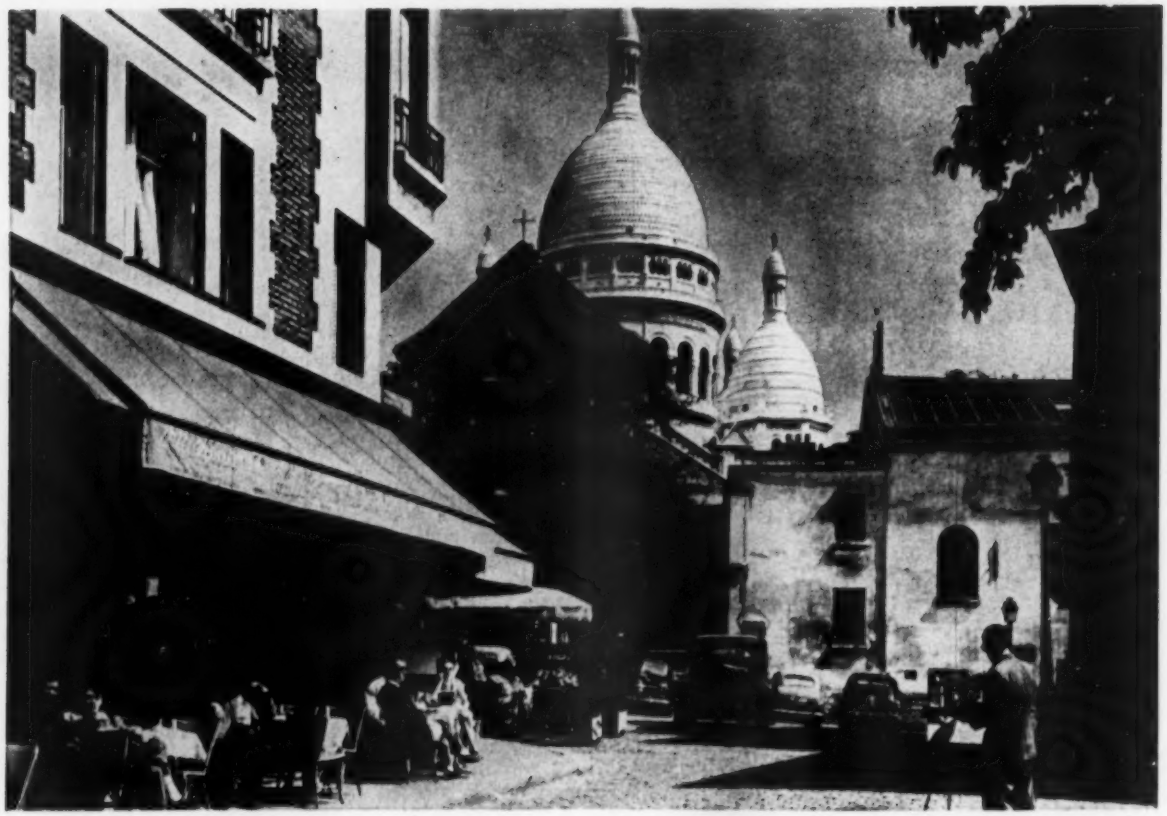

Street Scene, Montmartre, Paris

Only TWA flies from 60 U. S. cities to 21 world centers overseas!

TWA's luxurious Super-G Constellation Ambassadors fly non-stop to London, Paris, Lisbon . . . gateways to Europe and the Old World . . . providing de luxe First Class service with complimentary cocktails . . . delicious, full-course meals and vintage wines. The extra luxury of deep-cushioned TWA Sleeper Seats and full-length Sleeper Berths are also available. Or for great savings . . . there's thrifty, comfortable Sky Tourist. Whatever your choice, TWA offers 28 fast flights overseas every week!

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Finally, there's TWA's *"Fly now . . . pay later"* plan. Only 10% down . . . up to 20 months to pay balance! Call your TWA office today.

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TRANS WORLD AIRLINES

New York Authority May Include Caravelle Under Jet Noise Ban

New York—Sud Est Aviation would like to bring its Caravelle twin jet transport into New York International Airport during a sales tour starting next month, but the Port of New York Authority hasn't made up its mind whether to grant permission. Under PNYA regulations, turbojets at present noise levels are persona non grata at the authority's New York fields.

John R. Wiley, director of aviation for PNYA, said the decision will depend on how the French transport stacks up against Port Authority requirements that an airplane's noise level be "tolerable" to airport neighbors. The Boeing 707 in its present form is not considered tolerable by the agency. Boeing last year requested permission to bring its 707 to Idlewild but was turned down.

Information Gathered

Port Authority has asked Sud Est to provide data on the Caravelle upon which the decision may be based. Also, Port Authority engineers may check out the plane's external noise characteristics at some other airport after the plane gets to this country.

Sud Est says the requested information is being put together for PNYA and the firm is "very hopeful" that the Caravelle will be made welcome at Idlewild. If it isn't, Sud Est expects the refusal to have little or no effect on the sales tour. Nearby Westchester Airport has issued a standing invitation to the Caravelle manufacturers, and Republic Aviation would make its Long Island facility available.

PNYA holds to the public position it took in 1955 after Pan American signed the first American jet order for Boeing 707s. The authority said such jets as the 707 are unwelcome at their present noise levels.

Suppressor Progress

Wiley said manufacturers are working on noise suppression although as of now "we have nothing concrete to go on." Even if built-in suppressors don't show up in production jets flown by the airlines, flight procedures may be worked out to cut their noise to acceptable levels near the airports, Wiley said.

Aircraft noise and its effect on community relations is probably as big a problem to the Port Authority as to any civil airport operator anywhere. The bi-state independent agency has been walking on eggs in its airport public relations ever since the coincidence of three airliner crashes at Newark Airport in the winter of 1951-52 stirred the surrounding countryside to the boiling point.

Since then PNYA has cooperated in industry efforts to alleviate noise by special flight procedures, preferential runway use, and the like, and has devoted considerable effort to an intensive community relations program among its airport neighbors. Harassment by local groups and political axe grinders has been consistent for years.

What would happen if unsilenced jets went into airline use? Would New York cut itself off from this modern air transport service? Wiley says in effect that the Port Authority will meet the problem if and when it materializes. He points out that the size and importance of the New York air travel market makes it likely some solution would be found by the airlines.

PanAm Accused of Restraining Panagra

Washington—W. R. Grace & Co. has accused Pan American World Airways of unlawfully restraining the growth of Pan American-Grace Airways and has asked Civil Aeronautics Board to extend Panagra's routes to the continental United States. Grace's petition, filed in behalf of itself and Panagra, also urges CAB to preclude Pan American from attempts as stockholder in Panagra to prevent effective utilization of any routes the board might grant.

Pan American and Grace own Panagra equally between them. The petition claims that the airline's board of directors split four-four on a Panagra management proposal Jan. 10 that its officers be authorized to petition CAB for route extensions. All four Pan American directors, according to Grace, voted against the extensions.

Routes sought in the petition extend from Balboa to New York and Washington via Miami, and from Balboa to Los Angeles and San Francisco via Mexico City. Panagra can attain economic health, become subsidy-free only by getting its own routes into the U.S., Grace contends.

Pan American's own long-haul route to Buenos Aires is competitive with Panagra's route from Balboa to Buenos Aires, the petition notes, and "Pan American's persistent efforts to restrain competition from Panagra stem from a policy and an attitude toward Panagra which has been open and notorious."

Panagra's route mileage has shrunk as other international carriers have been expanding their routes, the Grace petition claims.

Sabena Helicopter Service to Start

Helicopter service between downtown Brussels and downtown Paris was scheduled to start this week with daily S-58 service by Sabena Belgian World Airlines (AW Jan. 28, p. 37).

Sabena scheduled a mass flight of its fleet of eight of the 12-passenger rotorcraft to inaugurate the new service. Time between Allee Verte Heliport, Brussels, and Balard Heliport, Paris, is an hour and a half.

SHORTLINES

▶ **United Air Lines** operated 349.9 million passenger-miles in January, up 6% from same month of 1956. Air freight total was up 38% for the month to 4.16 million ton-miles, mail was up 2%, express was about 1% under January, 1956.

▶ **National Airlines** sold 28% more package tours to Florida and the Caribbean during first month of 1957 season, Dec. 15 through Jan. 15. Rise in fly-and-drive business is indicated by 93% increase in rental car bookings, and extension trips to Havana and Nassau have risen 76%.

▶ **Overnight** New York-Hawaii special is being operated daily by American Airlines and Pan American World Airways, with American's non-stop Mercury connecting at Los Angeles with Pan American. Round-trip first class fare is $611.50. Coach-tourist combination by the two carriers provides New York-Honolulu service for $419 round-trip.

▶ **Canadian Pacific Airlines** has been licensed by Canadian Air Transport Board to extend its South American service to Santiago, Chile. CPA will fly from Vancouver or Toronto to Mexico City, from there via Lima, Peru, to Santiago, and then to Buenos Aires.

▶ **Wahn Airport** between Bonn and Cologne in Germany will be transferred to civil administration July 1. Field presently is used by Royal Air Force with limited civil schedules. Modern facilities will be established at Wahn by the German government.

▶ **New $1.11** million passenger terminal at Salisbury, Southern Rhodesia, was opened this month and operations moved from freight hangar. The $3.75

PLANE FAX

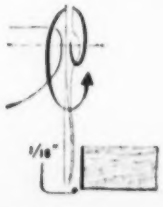
by STANDARD OIL COMPANY OF CALIFORNIA

Herding hungry ducks by air

Twisting back and forth above the rice fields in California's San Joaquin Valley, Frank Gallison drives feeding ducks out of the grain and toward surrounding game refuges and grasslands. Before he started this herding, farmers in the area often lost half a crop in a single day to migrating ducks.

One of the most experienced fliers in the West, Mr. Gallison has logged 20,000 hours, mostly in low-flying farm work. "Making turns 50 feet above muddy rice fields calls for plenty of extra power," he says. "I always get it with Chevron Aviation Gasoline, even on hot days when the engine is frying. It burns clean, too; never fouls plugs. I've used Chevron in all my light planes ever since it came out.

"And in spite of the tough flying I do, I've never had engine trouble since I started using RPM Aviation Oil. I've gone 1500, 1700, even 1900 hours between overhauls, until I take them down just because of the hours. 'RPM' holds wear down to next to nothing, keeps the rings and valves as clean as new. I wouldn't use anything else."



TIP OF THE MONTH

If your engine sounds rough, make sure your propeller "tracks" within 1/16-inch. Bring one tip down to a support, then pull the other down and measure the distance between it and the support.

We take better care of your plane

CHEVRON AVIATION GASOLINE

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T.M.'S "RPM," "CHEVRON," "PLANE FAX," REG. U. S. PAT. OFF.

million airport, opened last July, has handled 130,000 passengers, averaged about 50 aircraft movements daily.

▶ **Seaboard and Western Airlines** stockholders have authorized increase from 1 million to 1.5 million in company's one dollar par value capital stock.

▶ **Viscount 800** airliner went into first regular service last month on British European Airways' London-Paris route. New Vickers turboprop cuts 15 minutes from Elizabethan piston services over the BEA route.

▶ **Miami International Airport** handled 3,546,719 passengers in 1956, up almost ¼ million over 1955. Cargo totaled 163.3 million lb., mail 13.5 million lb.

▶ **Japan Air Lines** on April 5 will increase its trans-Pacific schedules from four to five weekly. . . . The airline also plans to add extra sections on the run during cherry blossom season, late March through early May. JAL also is increasing its domestic services next month.

▶ **Riddle Airlines** has added Norfolk, Va., to its scheduled all-cargo service points. Norfolk is the 22nd city to be served regularly by the carrier.

▶ **Lufthansa** has ordered two additional Viscount 810s for a total of nine. Deliveries are scheduled to begin in second half of 1958.

▶ **Western Air Lines** has declared a regular quarterly dividend of 20 cents a share, plus a 4% stock dividend on 779,131 shares of common outstanding.

▶ **American Airlines** carried 624,000 passengers 409,702,000 passenger-miles in January. Total was up 12.8% from January, 1955.

▶ **Trans World Airlines** will introduce its Lockheed 1649A Super Constellations domestically and internationally on July 1. TWA calls it the "Jetstream Starliner," expects to receive 25 this year.

▶ **Linee Aeree Italiane** has increased its Viscount 700D order from six to nine, with deliveries to begin in April.

▶ **VOR's** for Greece are being installed under auspices of U. S. Operations Mission at Athens, Salonika and Araxos airports. Omniranges were ordered by Greek government.

▶ **New Argentina** airport will be constructed in province of Missiones at cost of $1.67 million. First major airport in the province, it is being built under agreement with Air Ministry.

AIRLINE OBSERVER

▶ Aeroflot, USSR's state-owned airline, has opened a ticket office in Athens as a first step toward establishing an air link between Moscow and Cairo via Athens. The Mideast crisis has delayed the inauguration of the new Moscow-Athens-Cairo route.

▶ **Delta Air Lines is modifying its fleet of seven DC-6s to increase capacity from 70 to 76 seats in tourist configuration. New arrangement will provide an additional 40 million available seat-miles annually.**

▶ Trans World Airlines is distributing "service evaluation" questionnaires to pass holders in an effort to obtain a more realistic rating of all the airline's passenger service facilities. During trips, pass holders will checkoff 50 items ranging from telephone sales and reservations to baggage handling and limousine service. Each item will be rated by the pass holder as outstanding, good, fair or poor.

▶ **Pioneer Aeronautical Services has sold four Martin 202s to Allegheny Airlines and three to Southwest Airlines. Pioneer Aeronautical took over nine 202s from Pioneer Airlines when the Civil Aeronautics Board refused the local carrier additional mail pay to operate the more modern aircraft as DC-3 replacements (AW Oct. 5, 1953). The aircraft were a focal point in a mail rate case which resulted in the organization of Pioneer Aeronautical Services by the airline to own, charter or sell the Martin fleet and led to the eventual merger of Pioneer with Continental Air Lines. Remaining two Martins have been leased to the Glenn L. Martin Co. as electronic test beds. Allegheny holds an option to purchase the two airplanes being used by Martin when the lease expires.**

▶ Sabena Belgian World Airlines is expected to place an order for between 10 and 15 Fokker F-27 Friendship turboprop transports sometime this spring.

▶ **Scandinavian Airlines System's DC-7Cs are now operating over the polar route without encountering earlier sluggish operation of the pitch changing mechanism of propellers. Difficulty arose from freezing of hydraulic fluids while flying under extremely cold arctic conditions for prolonged periods of time. Hamilton Standard engineers corrected the problem by reversing the pressure relationship between two of the valves in the propeller governor and by installing an extra bleed valve in the prop dome to increase hydraulic circulation at low temperatures.**

▶ Saudi Arabia is negotiating with Convair for the purchase of 10 Metropolitan 440 transports.

▶ **American Airlines has organized a ground turbine training development program as part of its flying operations department to prepare for the introduction of jet transport service. Final plans for ground training on the Boeing 707 and the Lockheed Electra turboprop will be developed by Capt. Hamilton Carlisle Smith who will supervise the new program for the company.**

▶ International airlines are in disagreement on the quality and standard of passenger service that should be provided under the third-class fare scheduled to go into effect on April 1, 1958. Density of seating arrangement is chief source of contention with some airlines advocating less leg room and a reduction in the recline pitch of seats as a means of increasing seating capacity. Other airlines say such compressed seating will discourage use of third-class flights on long-range trips. Final decision on this and other points will be reached at International Air Transport Assn.'s traffic conference in Miami in September.

▶ **United Air Lines operations managers are attending an aviation institute on aeronautical engineering conducted by the University of Southern California. The institute consists of three sessions of 100 class hours each with approximately 25 personnel assigned to each group.**

EASE OF MAINTENANCE is key feature of General Electric CJ-805 turbojet. Based on J47 experience, the CJ-805 will require only 750 man-hours to overhaul; only .5 man-hours line maintenance per engine flying hour. The CJ-805 will begin service in TWA and Delta Air Lines' new fleet of Convair 880's.

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- to help determine your needs for tooling, test and handling equipment
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- to help you have the right ground support items at the right time, in the right quantity

For more information on what the CJ-805 offers your medium-range transports, contact your G-E Aircraft Engine Specialist. You can reach him via your nearest G-E Aviation & Defense Industries Sales Office. ***General Electric Company, Cincinnati 15, Ohio.*** 237-14

G-E COMPONENT DEVELOPMENT CENTER near Cincinnati is one of the most advanced jet facilities in the world. New materials and principles for advanced jet propulsion systems developed in these facilities are now being incorporated into CJ-805 design.

COMPREHENSIVE PRESENTATION on why the CJ-805 makes possible the ideal medium-range jetliner is available to qualified airlines. To arrange a showing for your engineering or management staffs, contact your nearest G-E Aircraft Engine Specialist.

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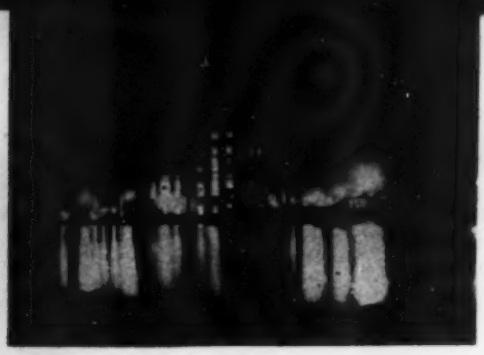
INFRARED-GUIDED Sidewinder missiles have deadly accuracy.



INFRARED mapping can reveal important military targets. Power plant (above) was photographed at night by visible light. Infrared photo (below) shows radiation from hot boiler and chimneys.

Exclusive Report on Infrared: Part I

Infrared Challenges Radar's Monopoly

By Philip J. Klass

Radar's long monopoly in the fields of missile guidance, target detection, fire control and mapping is being seriously challenged by infrared, an old technique which has acquired some new tricks.

There are some who predict that infrared, or IR as it is sometimes called, may largely replace radar within 10 years for missile guidance, target detection, and mapping if for only one reason: infrared can not be jammed.

A more likely possibility is that infrared systems will replace radar in some applications, supplement it in many more.

For example, both radar and infrared detection may be used in our defense against intercontinental ballistic missiles.

Hybrid systems, employing both infrared and radar techniques are another possibility. There is considerable similarity between radar and infrared systems. Once the target's infrared radiation is converted into a low-level audio-frequency signal it can be used for guidance or display in much the same way as a radar signal after detection. The parabolic-shaped scanner used to collect and focus IR energy closely resembles the parabolic-shaped antennas used in radar systems.

The remarkable accuracy achieved by the Navy's infrared-guided Sidewinder air-to-air missile, which has knocked flares off a drone's wingtip without destroying enough wing to disable the drone, has done much to focus military-industry attention on infrared. Hughes Aircraft Co., for example, is designing a new version of its radar-guided Falcon air-to-air missile to use infrared guidance.

De Havilland Aircraft Ltd. of England is also developing air-to-air missiles using an infrared guidance system.

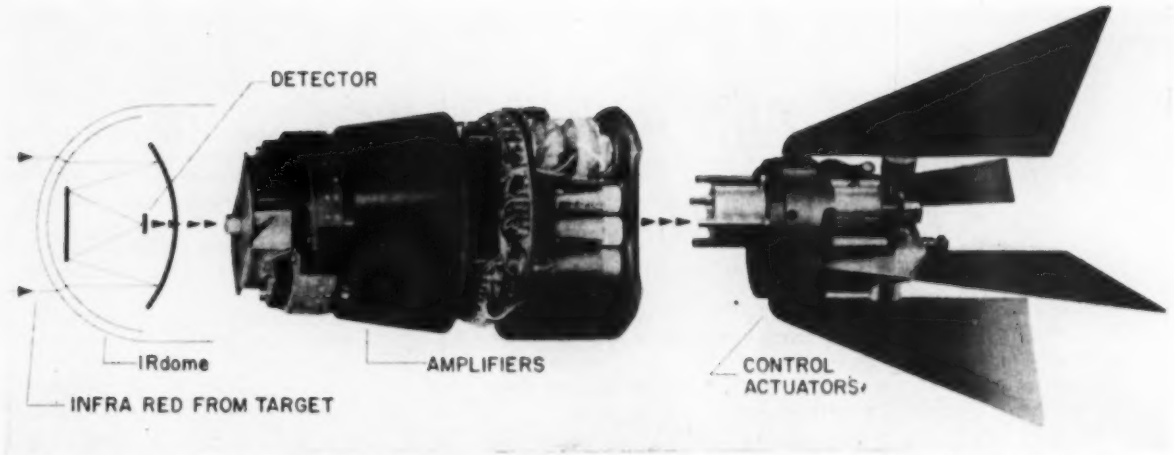
Many Uses

Infrared has important military uses in addition to missile guidance. IR systems can outperform radar under certain conditions in detecting high-speed jets and missiles. Hot jet exhaust gases and rocket motor flames make excellent infrared targets. An IR system can detect radiation from some stars in daylight, which suggests its use in automatic celestial navigation systems.

For mapping terrain, infrared can produce a "thermal photograph" or radar-scope type of visual presentation on a moonless night with far better detail than the best mapping radars. Under such conditions objects are delineated according to their temperatures. The brightness of the object on the scope or photo is a direct function of its temperature, thereby pinpointing such military targets as power plants and vehicles.

Secure Communications

Infrared can provide secure voice communications between two vehicles or ground stations without fear of enemy interception, an ever-present danger, with radio. The Navy is outfitting the Fleet with IR ship-to-ship communications that have a range up to 10,000 yards in clear weather at night. In the field of navigation, efforts are under way to develop a 10-20 lb. infrared ground speed indicator to compete with Doppler radar. Rome Air Development Center is investigating infrared for use in an automatic flare-out and landing system. During the recent Air Transport Association



INFRARED guidance system for missile is smaller, lighter, less complex and less costly than equivalent radar guidance system.

design competition for anti-collision systems, three companies proposed solutions using infrared systems.

One indication of infrared's fast-rising star is the rapidly increasing number of companies now active or interested in the IR field. Only a few years ago, a military request for industry proposals on new infrared system requirements brought responses from less than a half dozen firms.

Today it is not an unusual occurrence to find approximately 30 companies submitting bids.

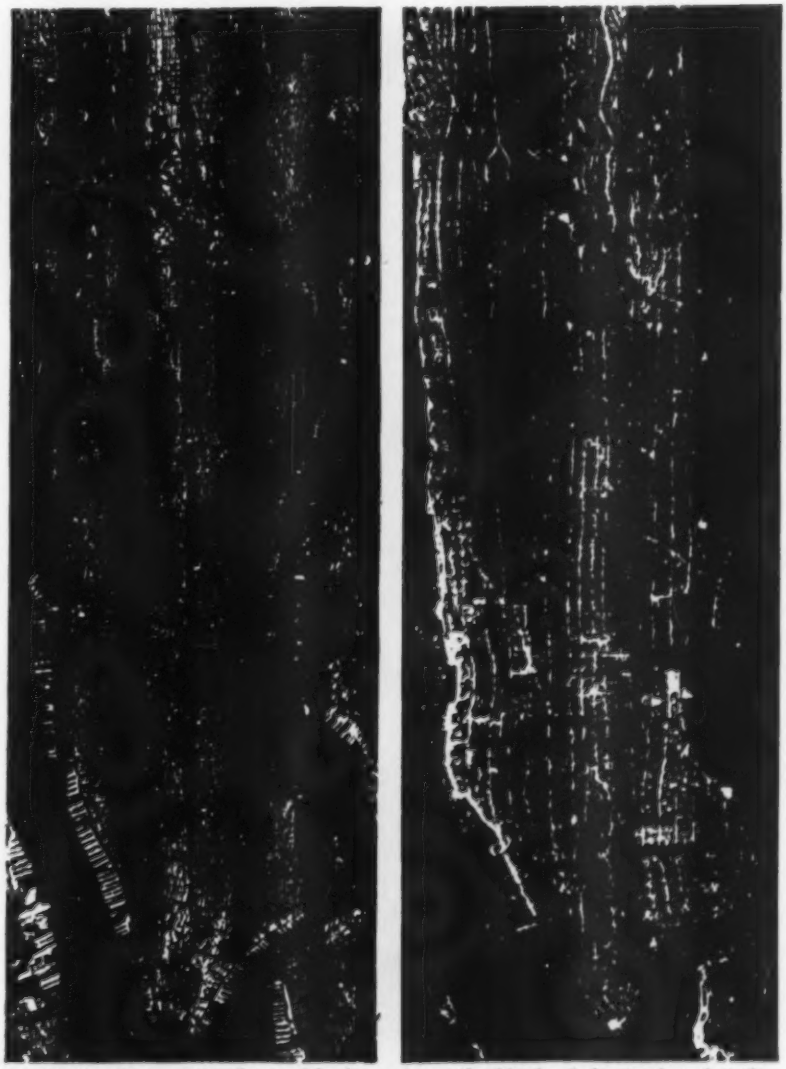
Mushrooming Industry

Firms known to be active in the development or production of military infrared systems and/or components includes:

Aerojet-General, Avion, Baird Associates, Barnes Engineering, Beckman, Bulova, Eastman Kodak, Electronics Corporation of America, Farnsworth, Farrand Optical, General Electric, General Mills, Haller Raymond & Brown, Hughes, Minneapolis-Honeywell, Perkin-Elmer, Philco, Production Research Corp., Radio Corporation of America, Raytheon, Servo Corporation of America, Servomechanisms, Texas Instruments and Westinghouse Electric.

A few of these companies, as Hughes, GE and Westinghouse, have extensive radar backgrounds but most, as Aerojet, Barnes and Eastman, do not. Generally speaking, IR systems can be designed with substantially smaller engineering groups than are required for radar systems.

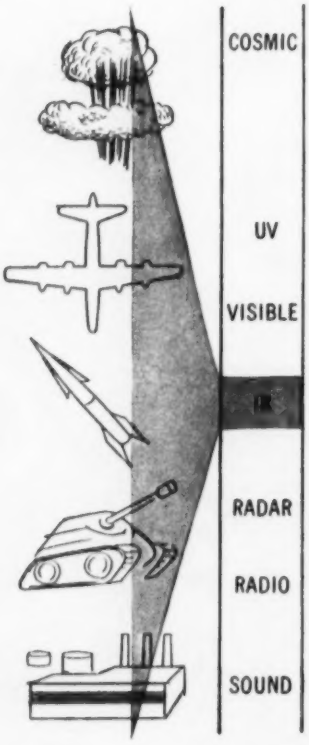
One of the acknowledged leaders in the field of infrared technology is the Naval Ordnance Test Station, China Lake, Calif., headed by Dr. William B. McLean. Dr. McLean recently received a $25,000 government incentive award for his contribution to the Sidewinder IR guidance development. The award



THERMAL photos of Manhattan Island reveal considerable detail despite fact that they were made nearly six years ago with equipment now considered obsolete. Photo at left was made at 10 in the morning, the one at right at 10 p.m.

Vestigia Energae Remanent

A science dating back to the Romans . . . rapidly advanced through modern research techniques . . . infrared now offers significant new answers to many military problems. A natural supplement to radar and optical physics . . . the use of infrared for detection purposes has been influenced basically by these factors:



All objects are natural radiators of infrared energy whenever molecular motion exists.

The more active the object . . . the more radiation. So, fission and fusion processes, jet engines, solid and liquid propellants, aerodynamic surfaces, reciprocating engines, combustion products, heavenly bodies, the horizon, and the earth itself are all substantial infrared radiators.

The present State of the Art permits the detection of objects having temperature differences of only a few degrees and also those as far away as 500 light years. These IR systems are suitable for a wide range of application including *early warning and detection; search, acquisition and track; missile guidance; communication; aerial mapping; navigation and altitude determination; countermeasures; fuzing; decoying; countermeasure initiation.*

Infrared can be used alone as a completely passive system, with either active or passive radar, with optical systems, and with electronic systems to perform a wide variety of tasks. Of course, many of these developments are secret, and most of them are confidential.

Whether your interest relates to a current application of infrared, derived from the present State of the Art; or to future weapons systems, based on sound research and development; you are invited to investigate Avion's experience in this field. It dates back to 1949 . . . is supported by a staff of recognized physicists . . . and profits from a valuable accumulation of pertinent data. This scientific team, equipped with modern laboratory facilities, is well qualified to go to work *for you.*

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was based on a government estimate that the Sidewinder had enabled it to save $46 million over the cost of comparable radar-guided air-to-air missiles (AW Dec. 10, 1956, p. 29).

A comparison of radar and infrared shows that the newcomer has a number of attractive advantages and some disadvantages, depending upon the application. Advantages include:

• **Every object radiates infrared:** Unlike radar, which must generate microwave energy and bounce it off the target, infrared systems detect the infrared radiation generated by any object whose temperature is above absolute zero (−273C). Thus, from a practical standpoint every object is an infrared source, although some are better targets than others as will be discussed later.

• **Less vulnerable to countermeasures:** Unlike radar, infrared radiation can not be jammed—so far as is known. However, it is possible to design countermeasures that will confuse or fool an infrared guidance or detection system by creating spurious sources of infrared radiation.

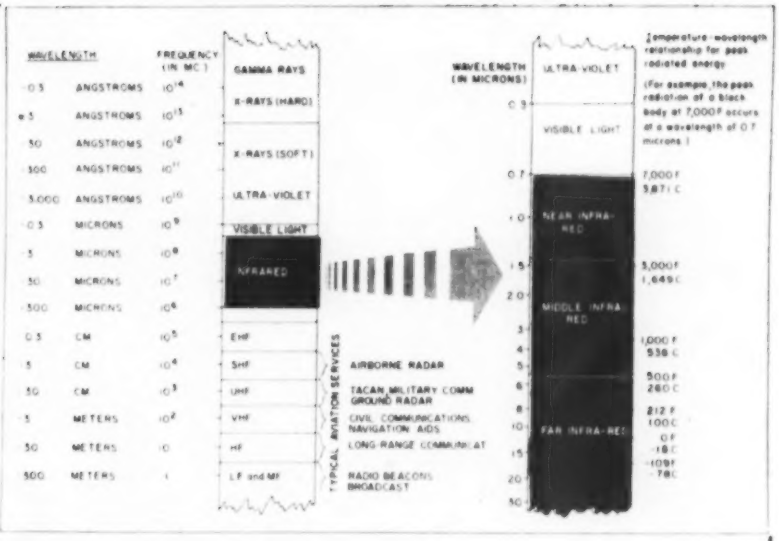
• **Cheaper, less complex:** Compared to radar, IR systems are relatively simple, lightweight, low cost. For example, the radar-guided Hughes Falcon costs about 10 times more than the Sidewinder, despite their similar missions. The Sidewinder uses only seven vacuum tubes whereas the Falcon employs several dozen.

• **Better definition:** Infrared operates at a frequency that is roughly 1,000 times higher than the highest frequency mapping radars. Since a radar or IR system's ability to resolve or discriminate between nearby objects is proportional both to frequency and antenna-scanner diameter, IR systems can use much smaller scanners than radar, yet achieve vastly better resolution.

Dr. F. E. Jones of Mullard, Ltd., speaking recently before the British Radar Assn., made the following comparison of the ability of radar and infrared to distinguish between two adjacent targets. At a range of five miles, an X-band radar (3 cm. wavelength) with a 12-in. diameter antenna can resolve two aircraft as separate targets if they are laterally separated by one mile or more. A radar operating at 8 mm. wavelength can do so if the aircraft are separated by as little as one quarter mile. But an IR system is able to resolve the individual engines on a twin engine airplane at five mile range using only a three-inch diameter scanner, Dr. Jones said.

• **Radiation Fingerprint:** Whereas a B-52 and a DC-6 may appear as identical blips on a radar scope, an infrared detection system can discriminate and in some cases identify the target by the spectral wavelength distribution of its

What Is Infrared?



INFRARED occupies spectrum band between visible light and microwaves of body.

Infrared is an electromagnetic radiation whose frequency, ranging from approximately one million to 500 million megacycles, falls between that of visible light and the microwave region used for high definition radars.

In some of its characteristics, infrared exhibits the properties of visible light and in others it more closely resembles radio or radar waves. For example, parabolical mirrors and lenses are used to collect and focus infrared energy, as with visible light. Yet infrared radiation can be transmitted through materials like silicon and germanium which are opaque to visible light.

Infrared radiation is generated by molecular thermal action within an object. Thus every object whose temperature is above absolute zero (—273C) where molecular thermal action ceases, radiates infrared energy.

Infrared radiation should not be confused with "heat waves" —the transfer of thermal energy by conduction or convection— although infrared usually produces heating in any object it strikes.

Thermal conduction or convection requires a physical medium such as air, through which heat can travel; infrared energy propagates through a vacuum as well.

A convenient and widely used reference in infrared work is the "black body." This, by definition, is an object which absorbs all radiation that strikes it without reflection. Radiation from a black body is the maximum possible for any given temperature and thus is greater than that emitted by any other object ("gray body") at the same temperature.

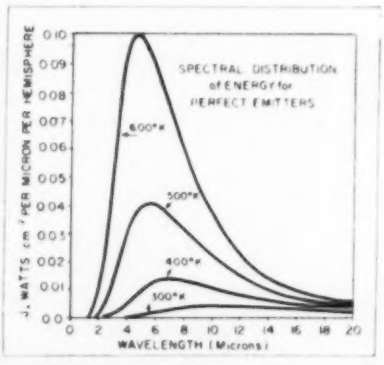
Infrared energy radiated by any object covers a wide range of frequencies, or wavelengths. The wavelength at which the maximum, or peak, radiation occurs is determined by the object's temperature. For example, peak radiation from an object at 500F occurs at a wavelength of about 5½ microns. (A micron, equal to 1/10,000 of a centimeter, is normally used to express wavelength in the infrared region.)

As the temperature of an object increases, its infrared radiation characteristics change in two ways:

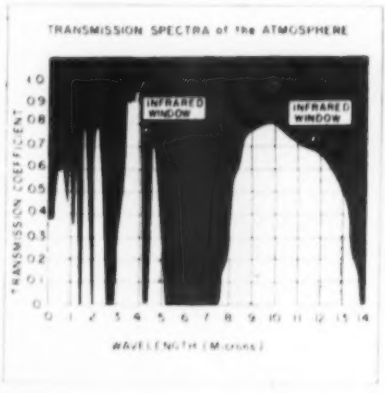
- Peak radiation shifts to shorter wavelengths and . . .
- Total radiated energy increases as the fourth power of the object's absolute temperature.

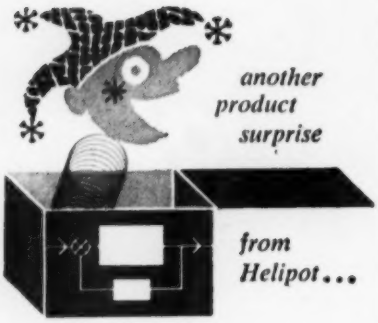
These fundamental infrared relationships are set forth in two laws:

- Wien's Displacement Law says that the wavelength at which peak radiation occurs is equal to a constant (K) divided by the object's absolute temperature in degrees Kelvin. (Absolute temperature equals the centigrade temperature plus 273.) For a "black body," the constant (K) has a value of approximately 2,960.
- Stefan-Boltzmann Law says that the total radiation from an object is equal to the product of its area (in square centimeters), the fourth power of its absolute temperature, a constant (equal to 5.672×10^{-12}) and the emissivity factor. The emissivity factor is the ratio of an object's radiation to that of an equivalent black body and always is less than unity (one) since the black body is an idealized radiator. The factor depends upon the material and its finish. Emissivity factor for a silver mirrored surface, for example, is 0.02; that for lampblack 0.95.



EFFECT of body temperature on intensity and wavelength of IR radiation is shown left. Atmospheric absorption of infrared energy as function of wavelength is shown (right).





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infrared radiation. This is possible because the temperature of an object determines the wavelength at which its peak infrared radiation occurs. Thus the radiation from a jet engine's temperature occurs principally at a wave length of about two to four microns while that from the cooler piston engine occurs at about eight microns. (A micron is equal to one millionth of a meter and is a convenient term for the infrared region because of its very short wavelengths. Thus three microns correspond to a frequency of about 100 million megacycles.)

The Air Force recently conducted tests atop Pike's Peak in Colorado to determine the infrared spectral radiation characteristics of a number of different types of piston and jet aircraft. The mountain site permitted measurement under high altitude conditions such as might be encountered by an infrared-guided missile.

IR Fingerprinting

A device which can be used for "infrared fingerprinting" is the airborne infrared monochromator, developed by Servo Corporation to measure wavelength and intensity of infrared radiation. Monochromators have been purchased by the USAF and French Air Ministry. A somewhat similar device made by Beckman, is being used by Boeing to check the spectral emission characteristics of various metals and high temperature resistant coatings at temperatures up to 1,400F, Beckman reports.

Nature seldom provides advantages without attendant disadvantages and infrared is no exception. Shortcomings of IR for military uses include:

• **No distance information:** Infrared systems operating from target radiation, called "passive systems," have no direct means of measuring distance to the target—information which radar obtains by measuring the time required to bounce its energy off the target. For missile applications as in the Sidewinder, this is no serious handicap. It is when IR is used for fire control systems. One way around this limitation is to use a ranging technique similar to that employed on a 35 mm. camera with coupled rangefinder. This requires the use of two infrared tracking heads physically displaced from one another. Range is determined from the angle between the lines of sight to the two trackers. Another approach, called stadiametric ranging, measures the angle subtended by the engines of a multi-engine aircraft assuming that the distance separating them is known.

• **Atmospheric and moisture attenuation:** Although high frequency radar suffers some attenuation of signal strength from moisture and oxygen in the air, infrared suffers far greater signal loss below 30-40,000 ft., except in certain parts of the spectrum called "windows." Systems designed for use at lower altitudes normally operate at wavelengths that fall within these infrared windows wherever possible. Heavy rain and fog can further limit infrared range, almost as severely as they do human vision.

DETECTOR, which converts infrared radiation into low-level electrical signal, is heart of all infrared systems.

• **Radiation everywhere:** The fact that every object radiates infrared, previously cited as an advantage, is a serious disadvantage when IR is used for missile guidance, detection, or fire control. Infrared energy from the sun, for instance, reflected from a fast-changing cloud formation might lead an infrared-guided missile astray from its jet engine target. Perhaps the most difficult part of infrared guidance system design is to endow it with the ability to discriminate between infrared radiation from the target it seeks and that from nearby objects. At least one infrared-guided missile program has foundered on this reef.

Infrared Not New

Many of the basic potentialities of infrared have long been known. For instance, shortly after World War I General Electric was experimenting with infrared for aircraft detection and was able to spot a light bomber at distances out to 22 mi. under favorable

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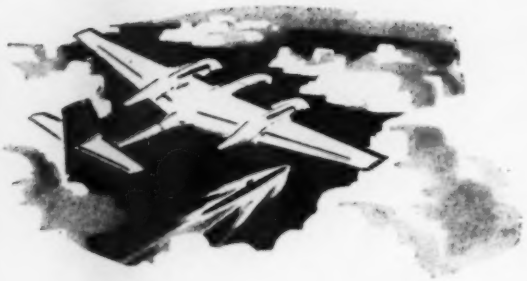

CYCLONE 9s add to the striking power of Royal Canadian Navy's GRUMMAN CS2F-1

A highly effective sub-hunter, the new De Havilland-built Grumman CS2F-1—serving the Naval Air Branch of the Royal Canadian Navy—is a deadly sub-killer too. Using radar to detect and track subs on the surface, and magnetic airborne detection (MAD) to zero on submerged craft, the CS2F-1 patrols the seas off Canada with an arsenal of torpedoes, depth charges and mines.

Every bit as important as the firepower of this new tracker is its engine power – twin Cyclone 9s by Curtiss-Wright. These modern powerplants, with the longest service background of any aircraft engine type, give the Grumman CS2F-1 its far-reaching overwater capabilities, its hour-after-hour dependability, its fuel economy for maximum patrol endurance and range.

Sub-detection is a vital part of a chain-reaction "offshore patrol" that day and night guards North America, and whose perimeter extends from the Arctic Ocean south around the entire continent. Everywhere in this protective network Curtiss-Wright power plays a leading role.

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weather conditions. GE also modulated IR beams for voice communications at distances of more than six miles. But then GE shifted its attention to radio detection, or radar, as it is now called.

Radar, the great technological breakthrough of the late 1930s and early 1940s, turned military and scientific interest away from infrared, except in Germany. During the war the Germans, and later the U. S. and Britain, devoted their major infrared efforts to "active" infrared surveillance systems, typified by the "sniperscope." These consisted of an infrared light source to illuminate the target at night, without the latter's knowledge, and an optical viewer which converted the reflected infrared into visible light enabling an infantryman or tank gunner to see his target. These types of active systems normally operate in the near-infrared region, at wavelengths shorter than approximately 1.5 microns.

German Use

The Germans employed infrared detection against Allied night bomber raids to supplement radar and to counter Allied chaff which confused German radars.

The Germans also experimented with IR for airborne interception and developed an infrared homing system for the Wasserfall anti-aircraft missile.

Although the Allies generally lagged behind the Germans in infrared work, there were a handful of infrared proponents whose enthusiasm was not diverted by the development of radar. Infrared guidance was applied experimentally to several glide bombs, finally got into limited production in a free-fall bomb called Felix which saw service in the China-Burma-India theatre shortly before the war ended.

Of the many missile study-development contracts awarded after the end of the war, most contractors turned to radar for terminal guidance with only a few exploring the possibilities of infrared.

Infrared received some military support for application to mapping and surveillance, but in the field of ground-based detection of aircraft, radar has ruled unchallenged—until recently.

Fire Detection

Before the advent of the Sidewinder, the most publicized application of infrared in aviation was its use in fire detection systems and more recently to detect an incipient explosion in a fuel tank.

The advent of the jet airplane and rocket propelled missile operating at vastly increased speeds with powerplants that make excellent IR targets and the mounting cost and difficulty of obtaining any further increases in radar range are primarily responsible for the

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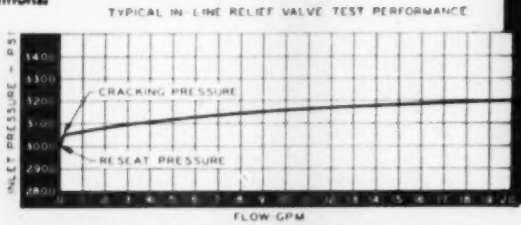

note low pressure change between full flow and reseat

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ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

keen interest which the military now shows in infrared.

Radar performance, which appears to be reaching a point of diminishing returns, may already have passed that point, in the eyes of many observers. To obtain a range of 300-400 mi. requires a lot of power and complexity.

Against a World War II bomber, such as the B-29, 400 mi. of radar range could give more than one hour's warning time. Against today's B-58, 400 mi. of radar range buys only 20 min. warning. Against tomorrow's hypersonic missiles, radar warning time drops sharply to a few minutes, unless elaborate and costly multi-station networks are used.

To make matters worse, the switch from propeller-driven aircraft to jets has resulted in aircraft which are poorer radar targets, effectively reducing the range of radar.

This results from the absence of propellers, which are very effective reflectors of radar energy, coupled with the more streamlined airplane configurations with smaller radar reflecting frontal areas.

Thus a given radar will have less range against a B-58 than against a B-29.

The hot gases spewed by a jet or rocket engine, coupled with its higher internal combustion temperatures, make it a much better infrared target than a piston engine. Reason is that the amount of IR energy radiated by an object increases as the **fourth** power of its absolute temperature.

Intensity of radiation at the peak wavelength increases with the **fifth** power of absolute temperature. (Absolute temperature, in degrees Kelvin, equals temperature in degrees centigrade plus 273; for example, 100C equals 373K.)

Rear Attack

Although the jet airplane's engine exhaust is the most inviting target for an infrared-guided missile, this limits an interceptor to a rear-hemisphere attack where it may be exposed to the bomber's tail defense armament. Furthermore, an interceptor may lose precious minutes in maneuvering into position for such an attack.

As airplane/missile speeds go up, aerodynamic heating of the vehicle's skin makes it an effective radiator of IR energy, although not as good as the power plant.

For example, a vehicle flying at Mach 0.8 at 30,000 ft. will have a skin temperature of about 250K. At Mach 2.4 its skin temperature is nearly double this figure, about 500K. This means that 16 times as much infrared energy is radiated at Mach 2.4 as at Mach 0.8, and the signal intensity in one

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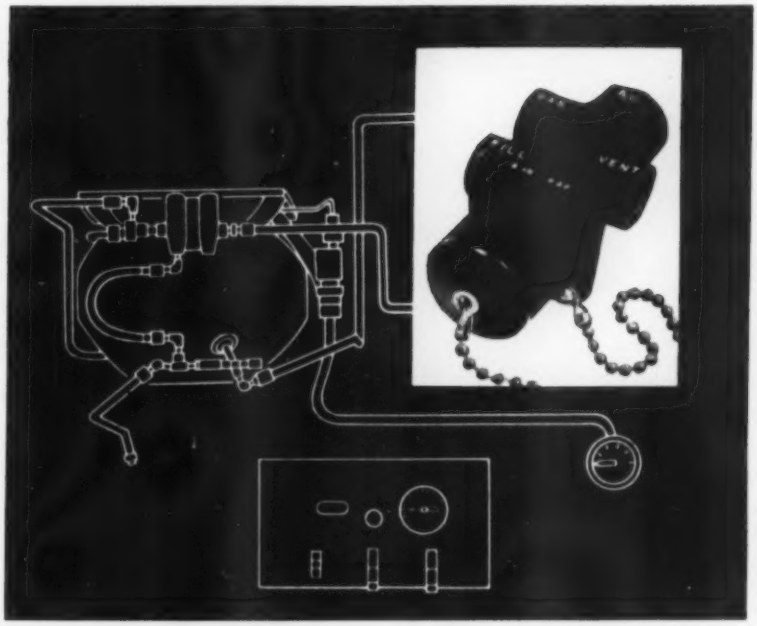

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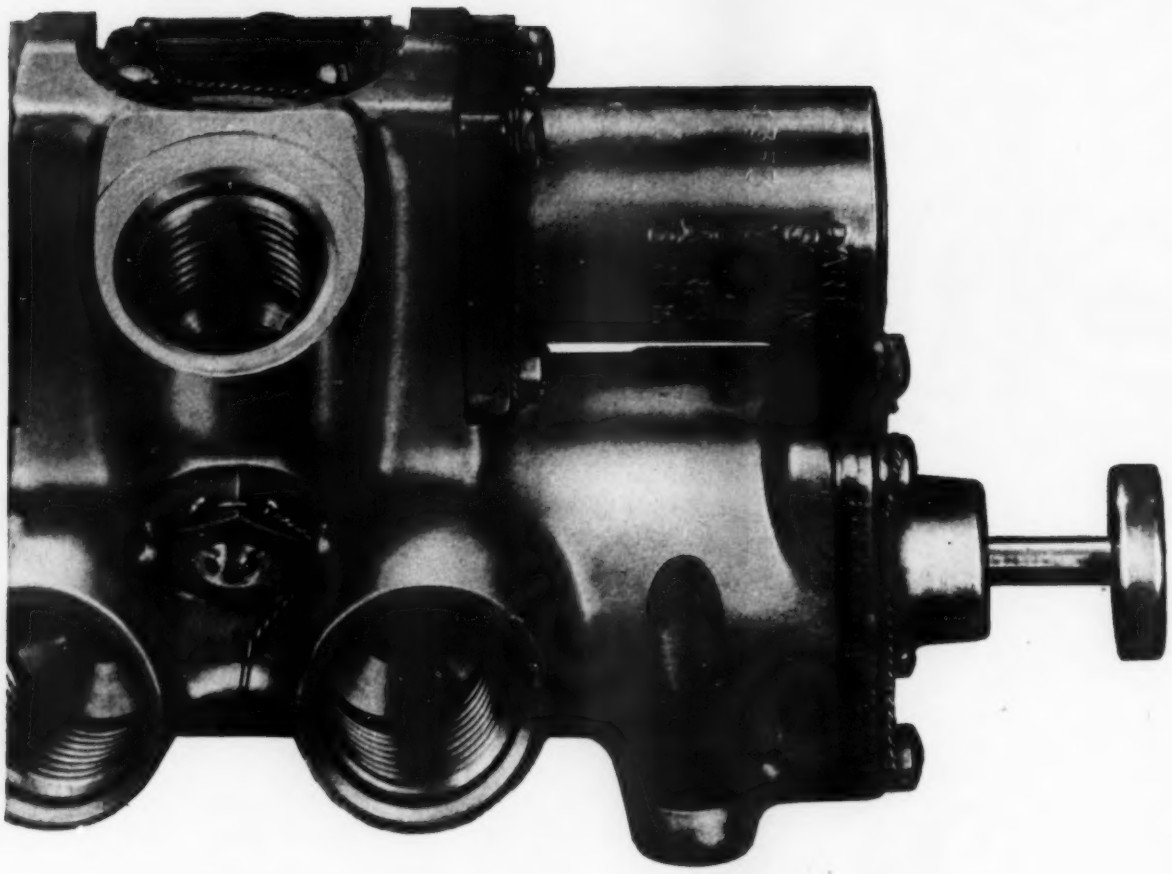

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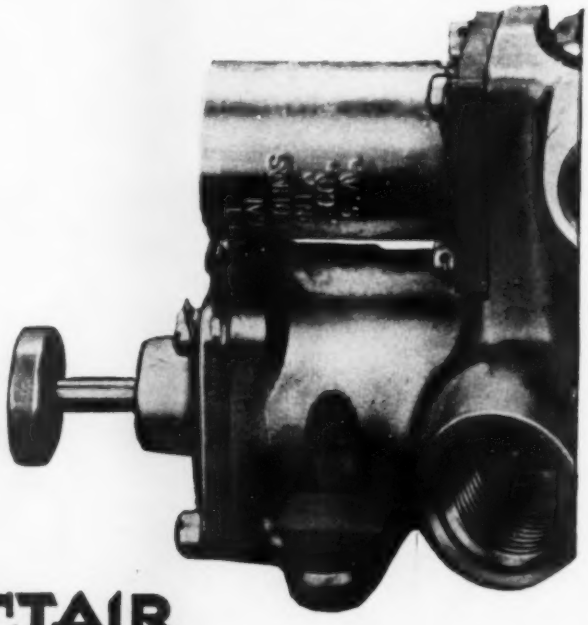

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portion of the spectrum is actually 32 times higher.

Translating this into effective range of detection, where range is proportional to the square root of radiation intensity, means that a Mach 2.4 vehicle theoretically could be detected at **five to six times** the range of a Mach 0.8 vehicle based on their respective skin temperatures. (This neglects the effect of infrared detector sensitivity and atmospheric attenuation variations in different potions of the spectrum, subjects to be considered later.)

Where a 300% increase in a vehicle's speed (from Mach 0.8 to Mach 2.4) would result in a proportional reduction in radar range, **measured in terms of time**, it could produce a 400-500% increase in range for an infrared detection system.

Infrared Restrictions

These are some of the factors which make infrared systems so attractive for missile guidance, fire control and target detection.

Where the radar designer has comparative freedom to select an operating frequency which will optimize the equipment performance for its intended application, the IR system designer is more handicapped by nature.

He has no control over the frequency at which the target's peak radiation occurs, because that is determined by target temperature. Thus he cannot shift frequency as easily as the radar designer to avoid those portions of the spectrum that heavily absorb infrared energy.

Nor can he boost power to compensate for this attenuation as the radar designer can.

The IR system engineer can only manipulate his infrared receiver design, a combination of optical, mechanical and electronic elements. Two of the most important of these elements are the infrared detector, which converts the low-level infrared energy into a useable electrical signal, and the optics which must collect a maximum amount of the available infrared energy.

Infrared detectors, optics, and system design considerations will be the subject of the second article next week in AVIATION WEEK's special report on infrared.

Reprints Available

Reprints of Aviation Week's special report on infrared will be available in approximately six weeks. Single copies will be available free to subscribers upon request. Other copies will be billed at the following rates:

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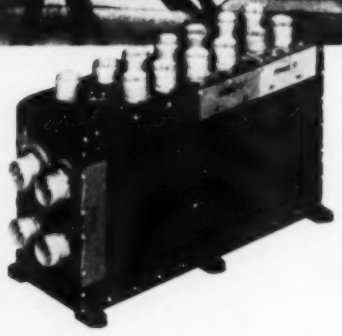

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Oversecrecy Defeats Itself, Scientist Says

By Louis N. Ridenour

We can distinguish three main components in the flow of technical and military information: first, the intercommunication of such information within industrial and governmental groups which are directly involved in closely related work; second, the flow of such information to the U.S. public at large, and third, its transmission to potential enemies of the U.S.

The aim of security restrictions imposed on information flow is to deny information of consequence to our potential enemies—which usually entails denying it to the public generally—while at the time imposing as little restriction as may be on the dissemination of this information among those who are judged to have a need to know it.

Usual Channels

Because the generally established channels for publishing information do not permit distinctions in the treatment accorded the three groups mentioned above, the usual publication channels are not generally used for classified information.

Not officially, that is—the energy and ingenuity of the aeronautical trade press in this and other countries have on some occasions surmounted difficulties in communication which have been imposed in the name of security.

At all events, the flow of aeronautical information is consciously manipulated in the name of security. The true goal of any alteration in the normal pattern of information flow is enhancement of our national security. The use of the word "security" to describe restrictions on the flow of information has a tendency to obscure this point, since in other connections "security" is a synonym for "safety." It is not necessarily synonymous with "safety" in the present connection, and this must be remembered at all times.

Two Categories

Generally speaking, there are two main categories of aeronautical information which are subjected to security classification. These relate, on the one hand, to existing military capability and, on the other, to research and development work which is mainly significant in terms of future military capability.

In times of nominal peace, such as we now enjoy, our national military establishment has as its main current value its deterrent effect on possible hostile actions of other nations. The supposed capability of this military establishment is presumably very carefully weighed when another nation is deciding whether or not to take steps inimical to our best interests. The deterrent effect of the Strategic Air Command has often been cited as the main shield of peace in the postwar world. Our preoccupation with the development of long-range ballistic missiles has as its goal the strengthening and improvement of our deterrent capability.

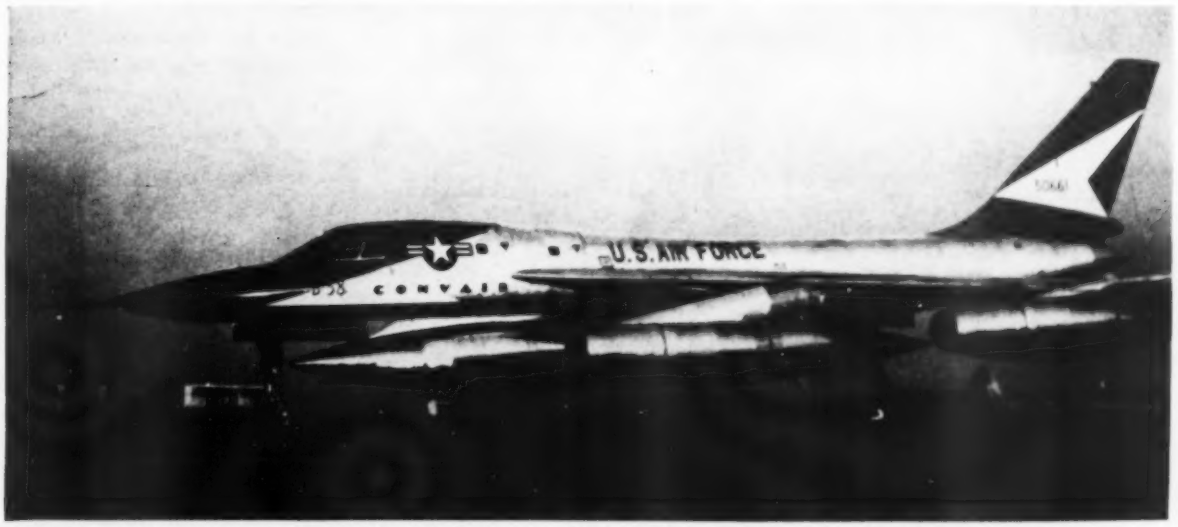
To have any deterrent effect, a military establishment must actually communicate to potentially hostile nations its approximate capabilities and order of battle. Otherwise, these total ca-

Dr. Louis N. Ridenour

The discussion beginning on this page on how secrecy impedes technological progress was given in Washington at the Second National Jet Age Conference of the Air Force Assn. Dr. Louis N. Ridenour, World War II Radar Expert, is now director of research and development of the Missile Systems Division of Lockheed Aircraft Corp.

Dr. Ridenour represented the aircraft industry in a program on the general subject of "The Flow of Information." Other speakers were:

- **Philip K. Allen, Deputy Assistant Secretary for Public Affairs of the Department of Defense, who defended the present security system.**
- **John Moss, (D.-Calif.) chairman of the House Subcommittee on Government Information, who discussed the current investigation of Defense Department policies.**
- **John E. Hull, retired U. S. Army general, member of the Coolidge Committee on Classified Information, who described the work of that group.**



CONVAIR B-58 HUSTLER ready for first takeoff with weapons pod. In Dr. Ridenour's view, "secret" B-58 deters no enemy.

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pabilities will not be taken into account when other nations decide on future courses of action. Thus we have the paradox that a genuinely secret weapon is absolutely worthless in peacetime.

All this is well known to our military leaders, of course. The recent epoch-making flight around the world by B-52s of the Strategic Air Command was simply a demonstration of the capability of our force-in-being, and was well contrived to dramatize our global retaliatory force. Unfortunately, however, this principle is sometimes lost sight of in the routine day-to-day regulation of the flow of aeronautical information. Secrecy is sometimes regarded as a virtue in and of itself, in disregard of the principle that a secret weapon has no value.

Real Secrets

Sometimes this happens because there is a category of information regarding current military capability that genuinely must be kept as secret as possible. I refer to that information which, while having little to do with the total capability that we should tell potential enemies about, is of such a nature that its knowledge by a potential enemy would simplify his task of defense by giving him leverage for effective countermeasures. A good example is the precise communications methods planned for use by the Navy or the Strategic Air Command. If these were known perfectly by any enemy, he could prepare himself to disrupt such communications at a time of his choosing, with potentially disastrous results. Another example is the detailed operating doctrine of such a force. Knowledge of this could greatly simplify defense.

Even with respect to such vital sorts of information as those just discussed, it is worth noting that unremitting concealment is still not the optimum policy. The theory of games developed by the late John von Neumann is able to prove conclusively that a mixed strategy—now bluffing, now telling the truth—is preferable to any fixed strategy such as that of attempting uniform concealment, in any situation such as the one obtaining here.

Where Security Stifles

The effect of security requirements on the flow of technical and scientific information mainly relates to future military capability. Even without any impedance or restriction imposed on information flow in the name of security, great difficulties exist in establishing effective communications.

The vast growth of our research establishment and consequent requirement for an increase in the numbers of scientific communications have not been met by the classical medium of technical communication—the specialized journal. Publication delays of a year or more are common, and means for abstracting, indexing and reviewing are inadequate.

Even though publication is lagging, the individual technical worker's task of "keeping up with the literature" is becoming ever more difficult. An important part of this difficulty is the growing bulk and significance of the Russian technical literature, which very few of our people are able to read. At the same time, the inadequate but still substantial growth of our own technical literature has placed severe financial demands on our technical societies, traditionally the sponsors of scientific and technical journals.

Thus, quite apart from security restrictions, our scientific and technical community is having great trouble in maintaining effective internal lines of communication. This is a matter of deep present concern. Experts in documentation are diligently seeking ways in which scientific communications can be improved. One recent effort of this sort was a conference held at Western Reserve University in January, 1956, on "The Practical Utilization of Recorded Knowledge—Present and Future." It is interesting in the present context to note that some of the sessions of this conference were held behind closed doors and that the full record of these "confidential" sessions was never publicized!

Aid to Progress

The basic reason for desiring prompt and effective dissemination of the results of scientific and technical work is that further rapid progress will thus be facilitated. When concealment of scientific work is considered in the name of security, it must always be remembered that the effect of such concealment will be felt both in our own development community and in that of our potential enemies. If our total technical competence is greater than his, then on balance we shall hurt ourselves by suppressing the free publication of technical information.

A good example is afforded by the Radiation Laboratory series of 27 technical volumes describing the work done during World War II on radar and microwave electronics. This series was dedicated to the proposition that the 5,000 or more technical man years spent on wartime radar development should not have a transitory value but, instead, should be preserved as a basic for further work. The resulting books, which appeared in the years 1947-1951, have sold very widely, both here and abroad. I have often heard them criticized by people who claim that we have "made a present" to Russia of everything we

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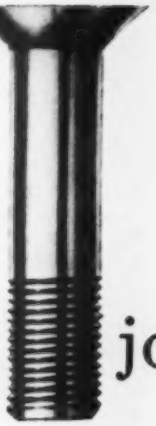

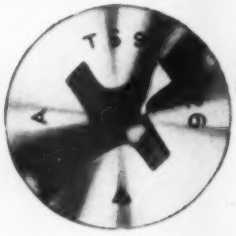

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learned, by taking so much effort, in this important field.

In my own opinion, this view completely overlooks the fact that we also made ourselves a present of the results of this work. And I think that no one can deny that we have made better use of this information than the Russians have done. Our advanced electronics progress is rapid and exciting; theirs has been sowewhat slower and more perfunctory.

Nuclear Jolt

The field in which Russia has given us our biggest recent surprises is that of nuclear physics. They exploded a thermonuclear device far earlier than they could have done on any timetable tied to espionage. At the Geneva conference on the peaceful uses of atomic energy, they startled our representatives by the scope of the thermonuclear work discussed. And this is a field in which we had been most cautious about publication.

Thus it is clear from the record that the technical interests of Russian science, far more than our own policies regarding the publication or suppression of technical information, have represented the major factor governing their progress. At the same time, our own progress was being slowed whenever we hampered or restricted publication of the results of our work in the past.

In the interests of security by achievement, as opposed to security by concealment, we should probably communicate as widely and promptly and effectively as we can the results of our massive current research and development program. To do less is to confess that our total development capability is inferior to that of our potential enemies.

In deciding who shall have access to information handled under security restrictions, much is made of determining whether or not a proposed recipient has a "need to know" the information in question. The "need to know" is a meaningful concept with respect to the sort of operational information that we have already noted must be closely held in the national interest.

It is far less meaningful in respect of engineering information. It is entirely without meaning in respect of highly creative engineering work or scientific research.

For a security officer to assert that such a man as Edward Teller does or does not have the need to know of the results of the scientific work of another man in his field is ludicrous and absurd. Teller, being a theoretical physicist, is engaged in improving our ordered understanding of natural phenomena. I am sure he has, before the fact, no way of judging whether or not the work of another man will help him in doing this. I am perfectly sure that no security officer could know; for, if he could, he could presumably replace Teller as a physicist, since he knows what Teller will next discover.

Even though we can see that the concept of the "need to know" loses its meaning at the wellspring of fundamental science, still we must appreciate the justification for the concern of security people with even the most advanced scientific work. This concern springs from the hitherto unparalleled speed with which fundamental scientific discovery is translated into practical engineering application.

Time Span

Half a century elapsed between the discovery of electromagnetic induction, which made the electrical power industry possible, and the birth of the industry. Fifty years later, a quarter of a century separated the discovery of radio waves by Hertz from the memorable day on which Marconi transmitted the letter "S" across the Atlantic Ocean. Only six years went by between the discovery of nuclear fission, which made atomic bombs conceivable, and the Trinity explosion in New Mexico.

Thus practical affairs, including military posture, are likely to be profoundly affected—and very promptly—

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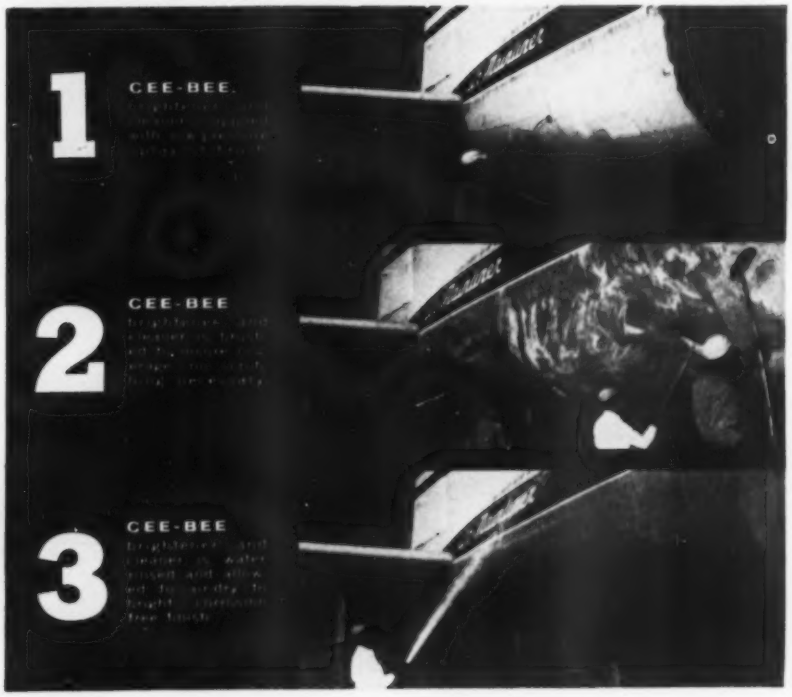

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by advances made in fundamental science.

Therefore, as much as we may deplore the meddling of security officers into scientific affairs, however inappropriate we know it to be, still we should appreciate the reasons which motivate this concern. The impossible task which the censors of scientific publication have undertaken is nevertheless one which—if achievable, as it is not—would be desirable.

Benefits of Research

Finally, we come to the obvious point that the results of the massive research and development program currently supported by military budgets are of the greatest possible use in developing the peaceful economy. A direct and immediate example of this is afforded by commercial air transportation, whose growth and development constitute one of the major technical phenomena of our age. It is not unfair to attribute a major part of the technical advance in our air transport capability to aeronautical developments sponsored and paid for by the military services.

These benefits to commercial aviation from military development work have come about only because of the timely release from security restrictions of the pertinent technical information. This illustrates how the general peacetime economy can benefit from technical development first made with military requirements in mind. Whenever the declassification and ordinary publication of such work is admissible from the military standpoint, there is no doubt of its desirability from the overall point of view.

There is evidence that cognizant agencies of the Department of Defense are aware of the dangers which inhere in the oversuppression of technical information interchange. However, I have sometimes encountered the attitude that the suppression of information is beneficial and worthwhile for its own sake.

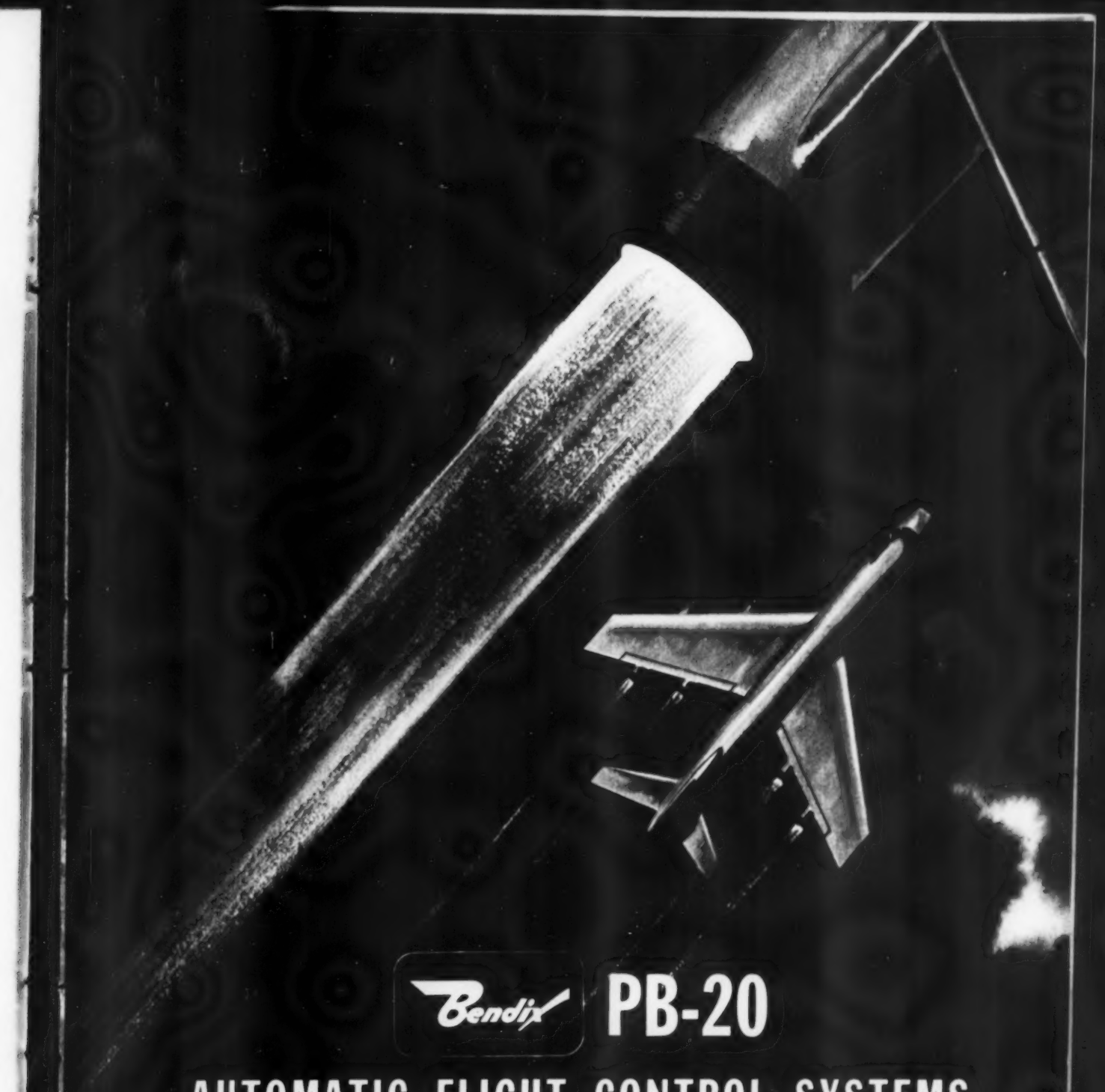
What Should Be Done

This, as I am sure we can all agree, is far from the case. We have seen that:

- **Information on present** military capability must reach the potential enemy to give the military capability any peacetime value.
- **Certain classes** of operational information must be most carefully safeguarded. These are defined by the leverage for countermeasures that they may afford.
- **Even with respect to** such sensitive information, unremitting suppression does not afford the best concealment.
- **Scientific information** is being propagated only with difficulty, even ignoring the efforts to impose classification upon it.
- **Suppression of technical** information will benefit us only if our development capability is inferior to that of other nations.
- **There is no such thing** as a meaningful definition of "need to know" in any scientific field.
- **The desire to regulate** scientific communication understandably springs from the present immediate connection between science and technology.
- **When military considerations** permit, the free release of technical information is always in the public interest.

This last point is true not merely because peaceful technology and military technology are closely related—though they are.

It is also true because a democracy can choose wise courses of action only when the people generally are adequately informed.



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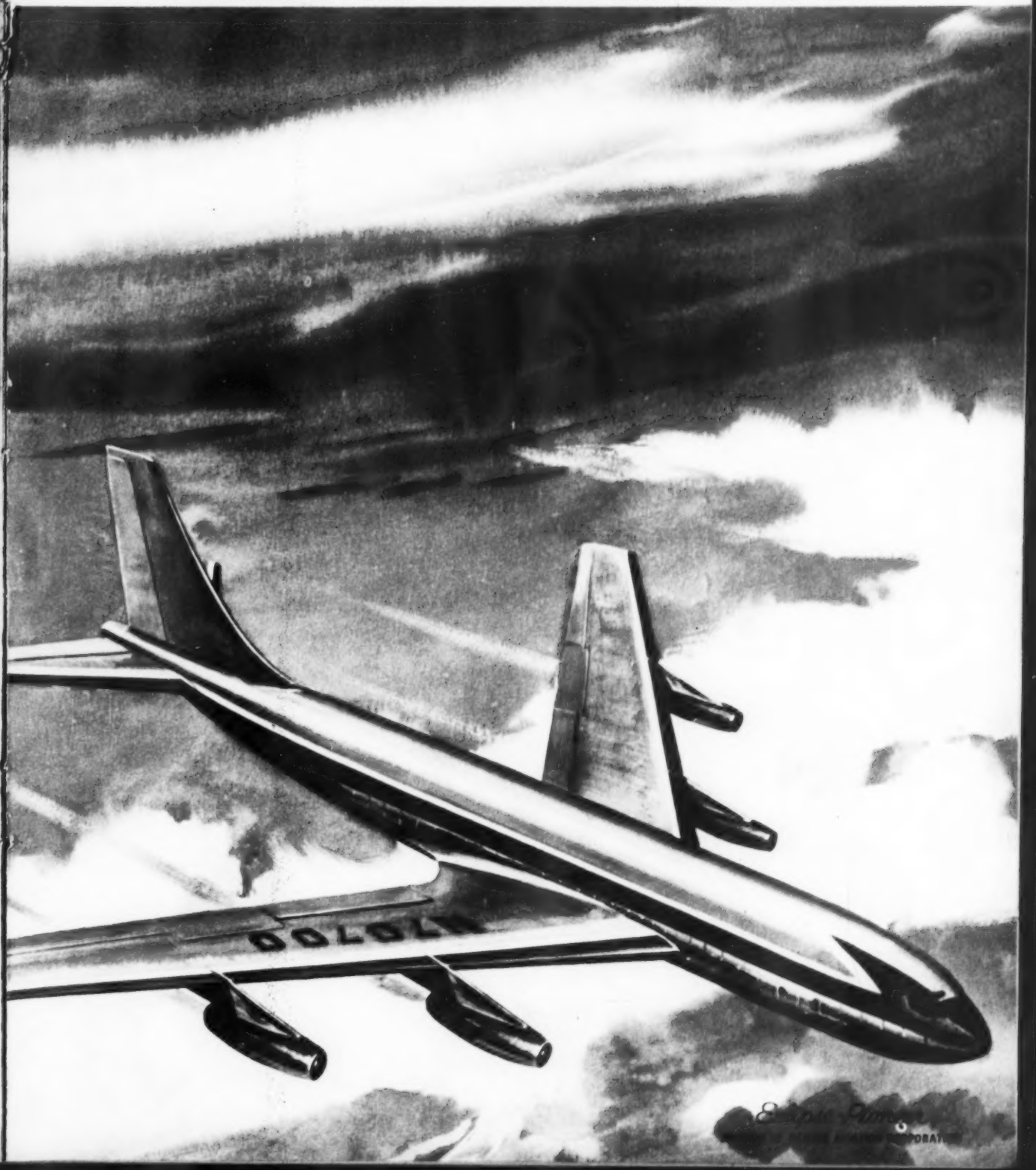

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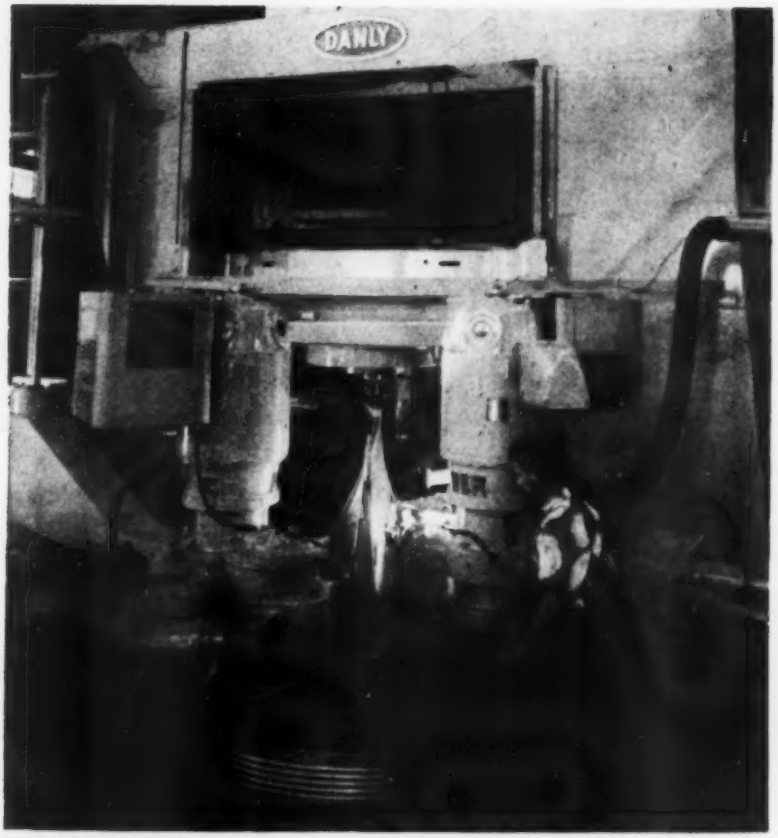

AMES AERONAUTICAL LABORATORY will use this 150-ton airfoil mill in advanced research. It can sculpture curved shape of airfoil or compressor blade in metal as it is doing to vertically-held piece at center. Danly Machine Specialties is maker.

Mill Sculptures Airfoil Shapes

Ames Aeronautical Laboratory, Moffett Field, Calif., has installed and is operating a milling machine capable of turning out complex curved airfoil shapes and turbine blades from blanks 18x18x96 in. for testing and use in the laboratory-supersonic wind tunnels.

The miller was designed and built for Ames by Danly Machine Specialties, Inc., Chicago.

The machine traces pattern blocks of size and shape identical to the desired final piece. Pattern blocks are held in place hydraulically, and the mechanism holding the blank can exert an upward thrust of 8,500 lb. Both pattern block and blank are held in place in the vertical instead of the usual horizontal position to eliminate any possible bending from the weight of the blank.

Two tracer wheels follow the pattern, transmitting the desired contours to two identically located cutting heads. Both pattern and blank revolve at the same speed to insure identical shapes. Finished parts can be held to tolerances of plus or minus .004 in. Cutting speed varies from a low of 78 fpm. for high alloy steels to a high of 3,140 for soft aluminum alloy.

Cost of the machine was $564,000, including design. The fully automatic machine covers more than 600 sq. ft. of floor space, and uses 17 electric motors to drive all components. Reliance Electric and Engineering Co., Cleveland, designed the controls.

GE Creates Industrial Diamond Substitute

A 3,500F industrial substitute for diamonds, which vaporize away at 1,600F, has been created by General Electric's General Laboratory, Schenectady.

Laboratory director, Dr. Guy Suits, considers the man-made material which GE calls Borazon after its two constituents, Boron and Nitrogen, as a potential substitute for diamond dust in industrial hard material grinding and a possible replacement for high temperature dry jewel bearings.

Dr. Suits also considers the new ma-

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This unretouched photograph shows the Lear Miniature Rate Gyro strapped to a jackhammer, riding side-saddle through two hours of pneumatic nightmare. After this "shakedown run" the gyro still performed up to the most exacting specifications set for the newest Air Force, Navy and Army missiles. This gyro is available right now. How many do you need?

LEAR MINIATURE RATE GYRO

LEAR INC.,
GRAND RAPIDS DIVISION,
GRAND RAPIDS, MICHIGAN

IP-14

torial an example of what can be expected from super-pressure research. The discovery, he says, is a classic example of how a scientist mixes basic knowledge with luck in making a fundamental discovery.

Borazon's discovery started when the similarity between graphite, which is diamond in the non-crystalline form, and "white graphite" or hexagonal boron nitride, was noted by the laboratory's Dr. Robert Wentorf. However, Boron nitride does not have graphite's extra electrons which permits graphite being bonded in a crystalline structure to become diamonds, a transformation which GE accomplished in 1955 by using 1,500,000 psi. super-pressures and 5,000F temperatures.

But when Wentorf used 1,000,000 psi. and 3,000F and a third substance which GE did not disclose, he was able to make the talc-like boron-nitride powder grow into crystals. The nitrogen atoms "donated" electrons to the boron atoms which in turn used the extra electron to form another chemical bond with a nitrogen atom until all the slip boundaries of the amorphous powder were interlocked together. The resultant "cubic boron nitride" is not only a substance unknown in nature but the first substance to have a hardness anywhere near a diamond's.

X-ray diffraction photographs further verified the similarity by showing that the Borazon crystal structure was practically identical to that of diamonds.

For industrial work it is expected to be superior to diamonds because it will withstand the higher grinding temperatures of the new high temperature materials which are becoming more popular, especially in aircraft, and it will ease our present dependence upon politically uneasy Africa as a sole source for diamonds.

The General Laboratories policy is to turn promising scientific discoveries over to GE manufacturing divisions for exploitation.

New Nickel Alloy Produced for Jets

A new high temperature nickel alloy expected to find use in highly stressed parts of turbojet combustor sections is being produced by the International Nickel Company. Another possible use is in the nose cones and airfoil leading edges of hypersonic aircraft and missiles.

The new alloy is similar in composition to the manufacturer's nickel-iron-chromium alloy but in addition it contains about 1.0% titanium. It is designed to operate at temperatures of 1,400F and higher.

The alloy sheets are annealed at 1,900F-1,950F. A good combination of strength and formability are reported by fabricators who process anneal their parts at 1,800F-1,850F from 20 to 30 minutes and air cool them rapidly. Tensile and rupture strength below 1,200F can be improved by cold working but the manufacturer advises against this if the part is to be welded because of the stress concentration which will form along the edge of the weld.

Cyclic oxidation tests conducted at 1,600F for periods from 100 to 1,000 hours showed that the weight change with time was about the same as that for the alloy without titanium. In both alloys the weight change is a gain because of the tight adherence of the oxide layer.

F-104 Crash Kills Lockheed Test Pilot

Palmdale AFB, Calif—Lockheed test pilot Joseph W. Ozier was fatally injured in a crash of an F-104A interceptor during a landing approach at Palmdale AFB on Feb. 15.

Ozier, 32, died of injuries on the following day. Observers said he appeared to be making a routine approach immediately before the supersonic Starfighter crashed.

A veteran of the Fifth Air Force during World War II, Ozier joined Lockheed in 1951. He was a founder and acting secretary of the Society of Experimental Test Pilots.

Bell HUL-1 Completes Fleet Indoctrination

Fort Worth—Bell HUL-1 utility helicopter has completed its fleet indoctrination program test ahead of schedule and is being delivered to Navy units for Arctic service.

HUL-1 completed a test program scheduled for 28 days in 18 flying days. The four machines used in the trials accumulated 501.2 hours of flight time.

During the test period, HUL required .74 of an hour for maintenance for each hour of flight. Bell points out that this record is substantially better than the average ratio of three hours of maintenance for every flight hour normally found in such accelerated test programs.

Admiral James S. Russell, chief of the Bureau of Aeronautics, praised the HUL maintenance record in a letter of commendation and said this aspect is most encouraging" because the HUL was ordered for use in remote areas and for logistic simplicity.

Bell is delivering the HUL to both Atlantic and Pacific fleet units. Helicopter's primary mission will be icebreaker patrol and support in the Arctic.

DATA

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MINIMUM "CROSS-TALK" – Patented design of torsion bar provides previously unrealized cross axis stiffness. Movements in insensitive axes virtually eliminated.

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VERSATILITY – Unit is available with either 26 or 115 volts, 400 cps., 3-phase or 115 volts, 400 cps. split single phase motor. Can be supplied for any maximum rate required. Unit is readily adaptable to requirements involving different signal outputs and damping characteristics. 2 and 3 axis packages also available.

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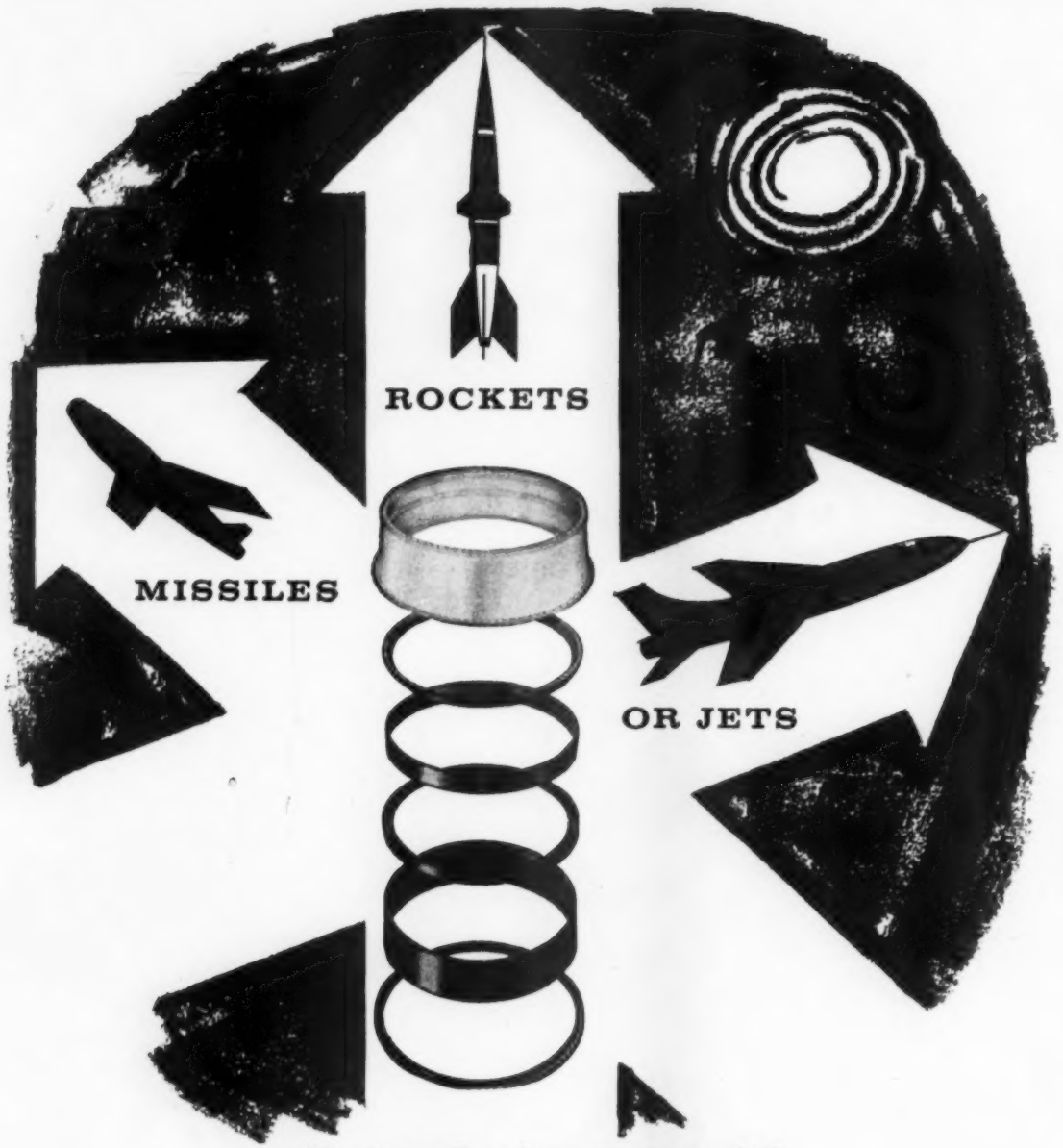

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British Report Progress on Angle-of-Attack Instruments

London—Flight guidance instrumentation based on angle-of-attack measurement instead of airspeed has reached an advance stage in Britain. This development was revealed to AVIATION WEEK by its inventor, R. T. Youngman, a design consultant and one of Britain's pioneer aeronautical engineers. The idea springs from his life's work with high lift and anti-stalling devices.

Using only a rudimentary computing element, the system continuously evaluates the pressure ratio between two stations on the wing profile. Its relationship with airspeed and angle-of-attack is used in a cockpit presentation showing the optimum angle for any flight condition.

Advantages of the system over airspeed sensing include:

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- **Quicker response** characteristics, as it measures cause of disturbance to wing circulation—not effect.

Limited Production

Extensive deck landing trials with straight wing naval aircraft have proved highly successful and are now to be extended to swept wing machines.

A limited production is already under way but Youngman states the system is to be standardized in all naval aircraft soon. It is to be tried out in the de Havilland Comet 3 airliner this month and according to Youngman, is already being used in flight trials with automatic landing systems.

The principal disadvantage of conventional airspeed sensing is its dependence on weight. To achieve and maintain optimum angles of attack for varying flying conditions the weight must determine the speed. Weight can have different values at takeoff and it changes considerably as the fuel is consumed.

Maintenance of the optimum angle becomes critical for different reasons in different aircraft. Very slight deviations at altitude for civil jet aircraft wastes fuel and frequent speed changes necessary (every half-hour in the Comet) to meet the speed and weight relation are indicated on charts carried in the aircraft.

Angle of attack instrumentation, by keeping airspeed constantly in phase with the weight, obviates step changes thus achieving the best fuel economy and reducing the flying effort.

Use of the system in naval aircraft makes deck landing safer, easier and slower. The pilot is able to approach safely at the optimum speed for the aircraft irrespective of the weight condition.

This fact together with the quicker response rates means stalling margins can be reduced and approach speeds lowered.

Most aircraft land at the minimum speed defined by the gross weight, which is consequently faster than need be.

Constant Ratio

The system owes its development to the simple fact that the ratio between pressure (p) at a selected position on the wing and the stagnation pressure $\left(q = \frac{\rho V^2}{2_g}\right)$ remains substantially constant for a given angle of attack for all air speeds. (It neglects R_n effects.)

The value of this ratio varies almost linearly with angles of attack as represented in Fig. 1a by the dimensionless ratio V/V, where V is aircraft speed and V, stalling speeds. The relationship in Fig. 1b is more difficult to calibrate.

The computing element can then be arranged to present the p/q ratio on a dial suitably calibrated to read the desired optimum values for varying flight conditions.

The p/q computing element in its original application took the form shown in Fig. 2 and it was used to monitor the Seaton Creaghe sound generator which is used as an aural aid for deck landing with the Navy mirror landing technique. It replaced speed sensing elements in the S. C. sound generator and has received extensive flight trials at the RAF Institute of Aviation Medicine Farnborough and deck trials on H.M.S. Bulwark.

Two capsules of equal size, sensing the p and q pressures respectively, act upon a beam so that their moments about the pivot balance at the optimum approach speed of 1.2Vs. For this value the instrument is independent of changes in aircraft weight and accelerated flight. But when the beam is deflected the capsule displacement characteristics introduce a deviation error of up to 15%.

Fig. 3 shows a servo version which instead of multiplying the capsule displacement, uses capsules of different

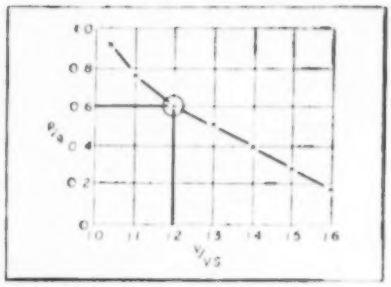


Fig. 1A

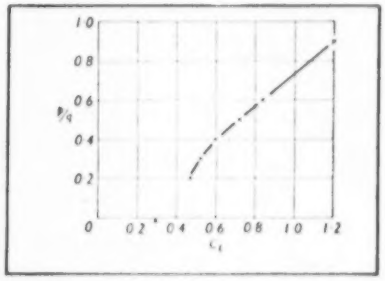


Fig. 1b

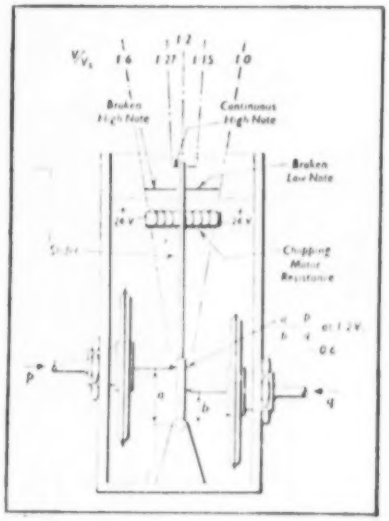


Fig. 2

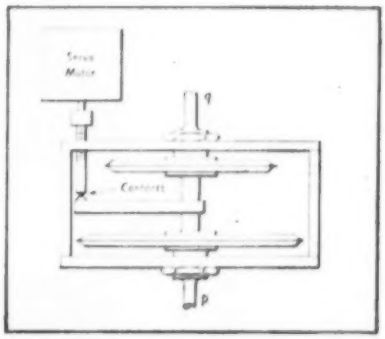
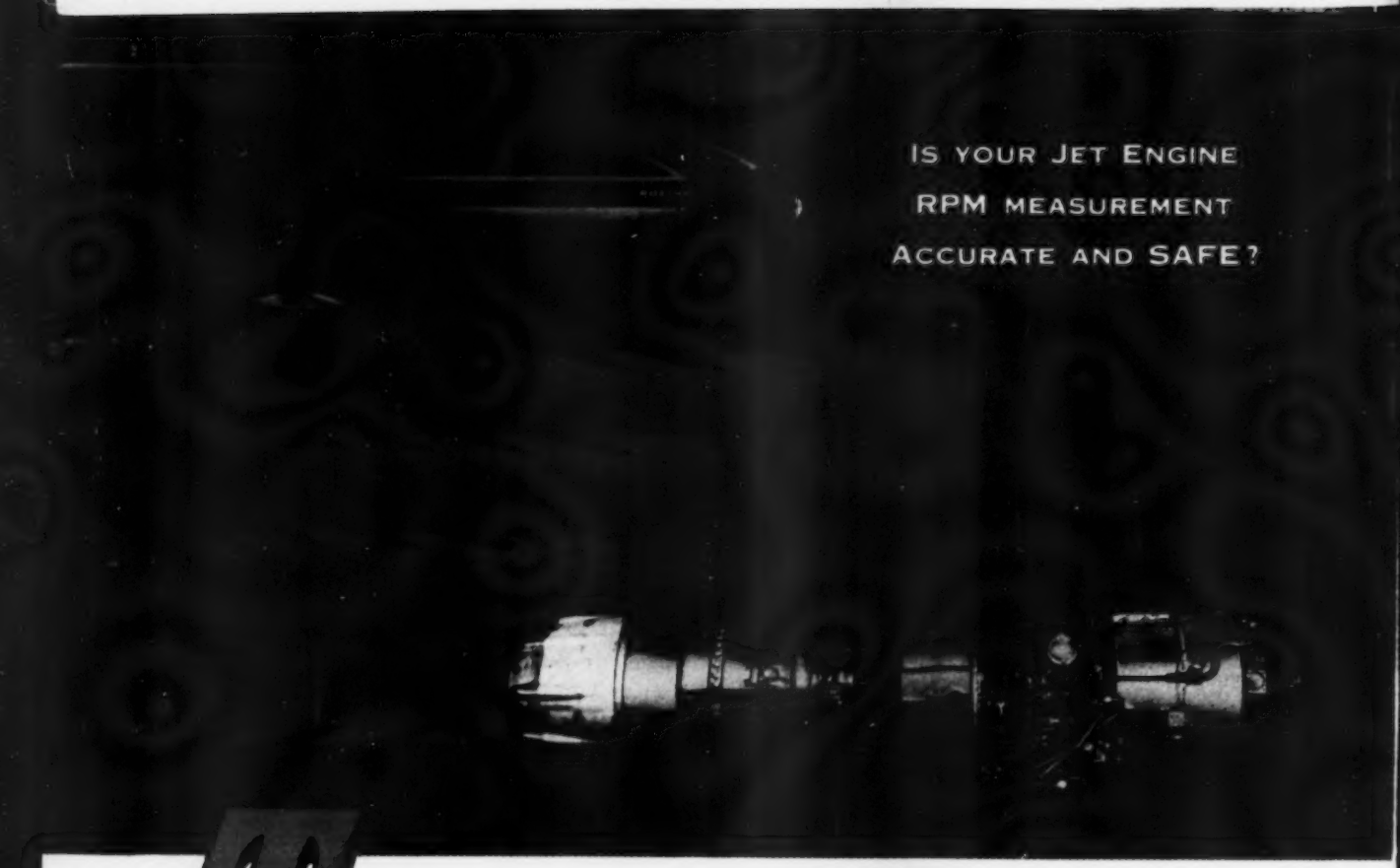


Fig. 3



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The new B & H TAKCAL incorporates a refinement of the frequency meter principle. It operates in the low (0 to 1000 cps) range, reading the frequency of the tachometer generator on a scale calibrated in percent RPM corresponding to the engine's RPM. It reads engine speed while the engine is running with a guaranteed accuracy of ±0.1% in the range of 0 to 110% RPM. Additionally, the TAKCAL circuit can be used to trouble-shoot and isolate errors in the aircraft tachometer system, with the circuit and tachometer paralleled to obtain simultaneous reading.

The TAKCAL's component parts are identical with those used in the J-Model JETCAL Analyzer. They are here assembled as a separate unit tester and for use with all earlier models of the JETCAL Tester.

The TAKCAL operates accurately in all ambient temperatures from –40°F. to 140°F. Low in cost for an instrument of such extreme accuracy, it is adaptable to application in many other fields.

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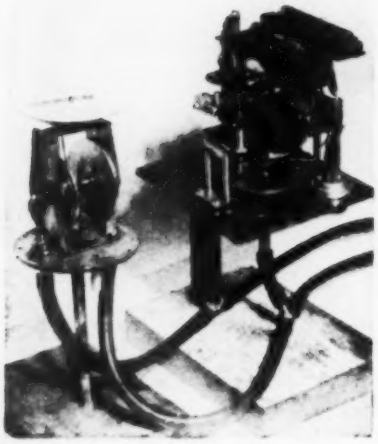

Fig. 4

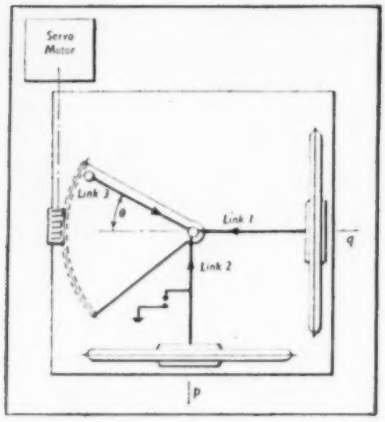

Fig. 5

effective piston areas arranged so that capsule restraint is nil at the optimum value of the pressure ratio. A servo motor follows up the capsule displacement by movement of a screw, its angular displacement being used to operate the wipers. One original version is shown in Fig. 4.

As no friction enters into the capsule movement, the sensitivity is governed by the servo hunt, which by the use of back contact relays and high precision gearing has been increased to 0.25 kt.

The latest form now favored for general development is shown diagrammatically in Fig. 5. It determines the p/q ratio over the whole possible flight range and can therefore be used to determine the angle of attack under all flight conditions.

Two capsules are mounted in a frame at right angles to each other. Links run from the capsules to a pivot where they meet a third link which is rotatable about the pivot. If the capsules are of equal size then tan $\theta = p/q$. A servo mechanism is arranged to swing the third link so that links one and two remain perpendicular thereby summing vectorially the capsule forces and determining θ. This can be used as a suitable basis for calibrating the cockpit presensation.

Aerophysics Designs Rotating Balancer

A simple vertical balancing machine capable of dynamic balancing of large rotating elements such as spin stabilized rocket motors, rotating launchers, heavy fly-wheels and turbines has been designed by Aerophysics Development Corp. Rocket motors may be tested while firing. The unit is capable of checking equipment weighing up to 5,000 lb. and producing 20,000 lb. of thrust. Maximum dimensions of specimen unit are 10 ft. in length and three ft. in diameter. Rotating speeds are up to 10,000 rpm.

Units weighing several hundred pounds have been balanced to an accuracy of about one-millionth of a radian. The test and correction procedure took about an hour.

With minor changes in the suspension system, the test stand may be adapted for measuring jet misalignment of rocket motors generating from 100 to 20,000 lb. thrust. Five of the stands are now in use.

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ENGINEERING BULLETIN

ON MICRO BEARINGS

Miniature Instrument Ball Bearings

NEW HAMPSHIRE BALL BEARINGS, INC.

PETERBOROUGH 1, NEW HAMPSHIRE

Subject: **FACTORS TO CONSIDER IN MINIATURE BEARING APPLICATION**

TYPES OF BEARING

The Retainer Bearing fitted with the one-piece crown retainer is well suited for the great majority of instrument applications. Even ball spacing produces good performance at low-moderate speeds, and it can also handle radial or thrust loads. Improved fabricating techniques result in crown retainers being specified for low-torque requirements.

Phenolic Retainers machined from phenolic plastic allow higher speeds and also provide some retention of lubricant. This retainer is used with angular contact bearings where one land is ground away from the inner or outer ring to permit bearing assembly. Such a design permits thrust *only* in the direction of the side having the full land.

CROWN

PHENOLIC

The Full Bearing has a full complement of balls. Filling notches are ground on one side of each ring to allow assembly. This type is steadily being replaced by retainer bearings which cost less to manufacture and assemble. It has an advantage for certain applications requiring maximum radial load capacity, but is unable to handle thrust loads because of possible interference between the balls and filling notches. Contact between the balls creates friction which makes the full bearing unsuitable for low torque or high speed applications.

MATERIALS

Stainless Steel's anti-corrosive properties have made it first choice for bearings used in precision instruments, and it has become one of the standard materials for this purpose. It can be ground and finished to a high degree of precision.

Chrome Steel should only be specified when bearings must operate at critical limits of capacity, a condition not often encountered in instruments. It has a somewhat higher load rating than stainless steel but is subject to rapid corrosion if not protected during handling and use.

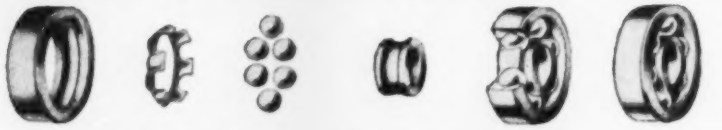
Beryllium Copper should be restricted to applications which definitely require non-magnetic properties in the bearings. All components of the bearing are fabricated from this material. If non-magnetic properties are not required, stainless steel is a better selection.

LOAD RATINGS

A miniature bearing is seldom operated at or near its rated load capacity. However, the designer must have sufficient information to assure intelligent selection. The load ratings presented in the New Hampshire Ball Bearings, Inc. catalog tables are based on standards established by the AFBMA after extensive studies and tests.

Dynamic load ratings apply to bearings that are rotating. Time-consuming calculations can be avoided by making use of the C factor shown in our catalog.

Static load ratings apply to bearings at rest. Since this exists in relatively few cases, static load rating is not usually given much emphasis. Formulae have been developed, however, and the need for this information is increasing, — primarily for units subjected to shock loading.



Retainer Bearing — Exploded and Assembled Views

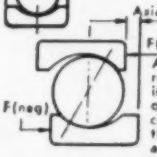
Retainer Bearing — Flanged and Shielded

RADIAL AND AXIAL PLAY

Radial play is the displacement of one ring with respect to the other along the *diameter* of the bearing.

It is important in the successful application of precision bearings and should be specified in orders. A range of .0002" to .0005" is satisfactory for most applications but tighter or looser clearances may be required. The minimum clearance should be .0001" and the total spread from min. to max. should be at least .0002".

Radial Play — Maximum distance one race may move diametrically with respect to the other without the application of measurable force when both races lie in the same plane.



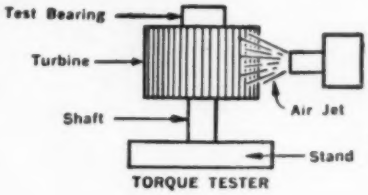
Axial Play — The maximum relative axial movement of inner race with respect to the outer, when both races are coaxially centered, without the application of measurable force.

Axial play is the displacement of one ring with respect to the other along the bearing axis. It is specified only when axial positioning of the shaft must be held within certain limits. Radial and axial play are mutually dependent factors and the former is the one usually specified.

TORQUE TESTS

Sensitive instruments require bearings with minimum inherent friction. Starting, or breakaway, torque is most often used to define limits. This is the force necessary to induce rotation from standstill under clearly established conditions of mounting and loading.

Torque tests can reveal much about the true quality and geometry of the bearing. Investigations being conducted constantly are producing valuable contributions to the refinement of instrument bearings.



TORQUE TESTER

MOUNTING PRACTICE

An improper fit to the shaft or housing can cause malfunctioning and failure of a precision bearing. The factors vary so with each application that bearing manufacturers are reluctant to make definite recommendations unless adequate information is furnished. The user cannot be sure that he has selected proper fits unless he has considered the variables involved in the manufacture of both instruments and bearings.

For selective assembly "coded bearings" can be supplied. This involves sorting bores and outside diameters in .0001" increments. It produces four possible groups within the quantity ordered but quantities in any *one* group cannot be assured. Coding should be specified only when definite advantages justify the additional cost.

DESIGNERS HANDBOOK *FREE* TO ENGINEERS

If you work with miniature bearings, you'll find this new, 70 page authoritative publication a great help in solving problems in designing instruments or small electro - mechanical assemblies.

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OLYMPUS 6 engine, rated at 16,000 lb. thrust, is mounted in new Bristol test cell.

Bristol Builds Dual Test Plant

Test plant constructed by Bristol Aero-Engines Ltd. is designed to handle engines up to 25,000 lb. thrust, and with minor modifications to the engine mounting cradle, engines to 40,000 lb. thrust.

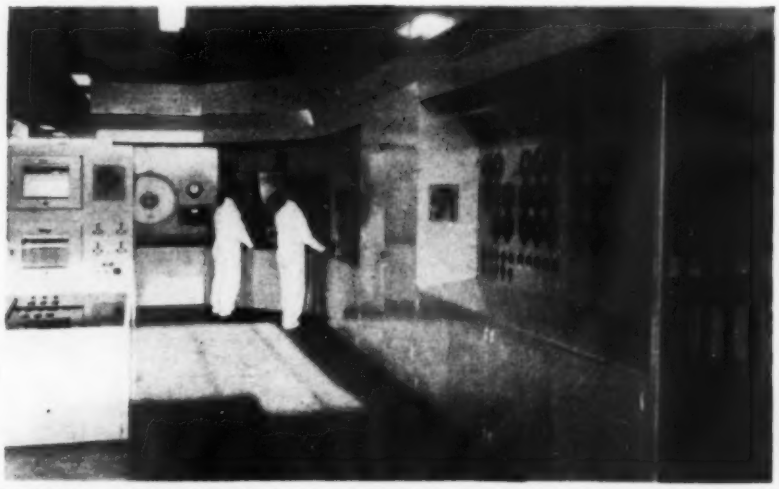
Currently the plant is being used for ground running of the Bristol Olympus 6 turbojet engine. The engine has completed a 150 hr. type test run at 16,000 lb. thrust.

Bristol said the engine thus became the most powerful type tested engine in the world. Thrust of 17,300 lb. has been observed during running.

To avoid duplication of essential units, the new plant has been designed as a double unit, with one test cell on either side of a central control room. Three 60,000 gal. tanks, capable of delivering 400 gpm. to the plant, provide fuel for engines on test.

Noise of the jet blast is muffled by fork shaped detuners. Two are connected to each cell by a fork shaped duct.

Jet blast is deflected vertically at the twin outlets of each unit.



CENTRAL station between dual test cells controls ground running of engines.

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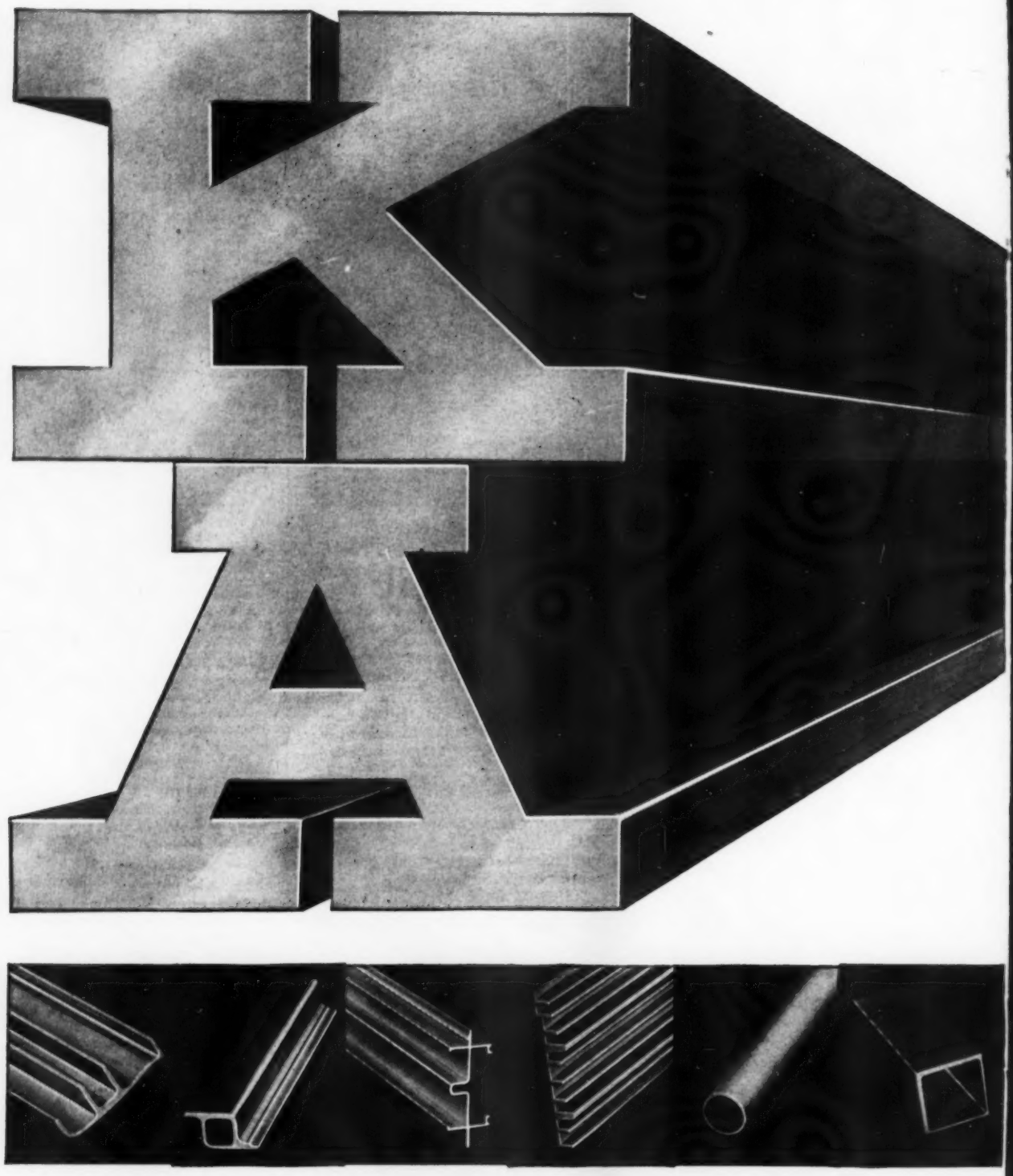

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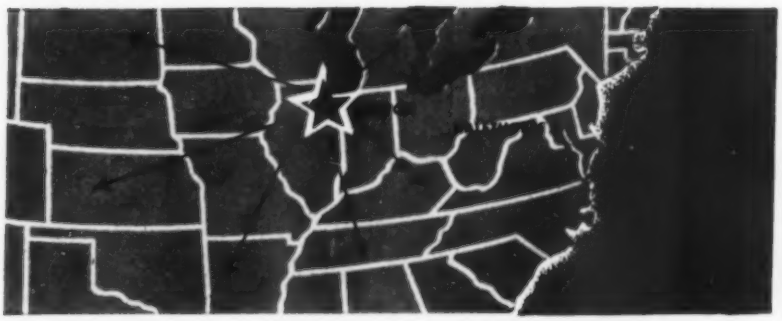


Kaiser Aluminum's new, modern extrusion plant at Dolton, Illinois now makes possible even faster service to users in midwestern industrial centers.

Strategically located in the heart of America's industrial complex, the Dolton plant's expanded production facilities assure you of an abundant, convenient supply of high quality aluminum extrusions.

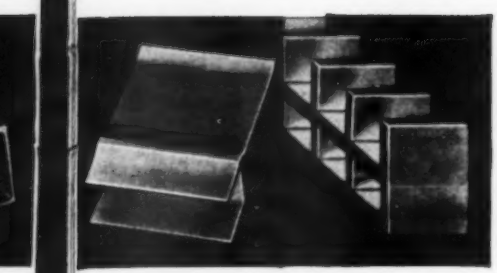
Production facilities include five extrusion presses—two 850-ton presses, one 1250-ton press, one 2100-ton press and a 3000-ton press now being installed. The plant can supply 18,000,000 pounds of quality extruded shapes and tubing a year.

Modern remelt, billet casting and die making facilities, plus a 100-ton stretcher, make Kaiser Aluminum's Dolton plant one of the most complete extrusion plants in the country.

THREE KAISER ALUMINUM EXTRUSION PLANTS SERVE YOU

With the new plant at Dolton, *three* Kaiser Aluminum extrusion plants are now in operation to meet your increased demands.

At Halethorpe, Maryland, Kaiser Aluminum operates two other plants; one with an annual capacity of 46,000,000 pounds, the second with an 18,000,000 pound annual capacity.



Two huge 8000-ton heavy presses in the second Halethorpe facility produce hollow shapes up to 17 inches in maximum cross-sectional dimensions, and flat sections up to 24 inches wide, 85 feet in length.

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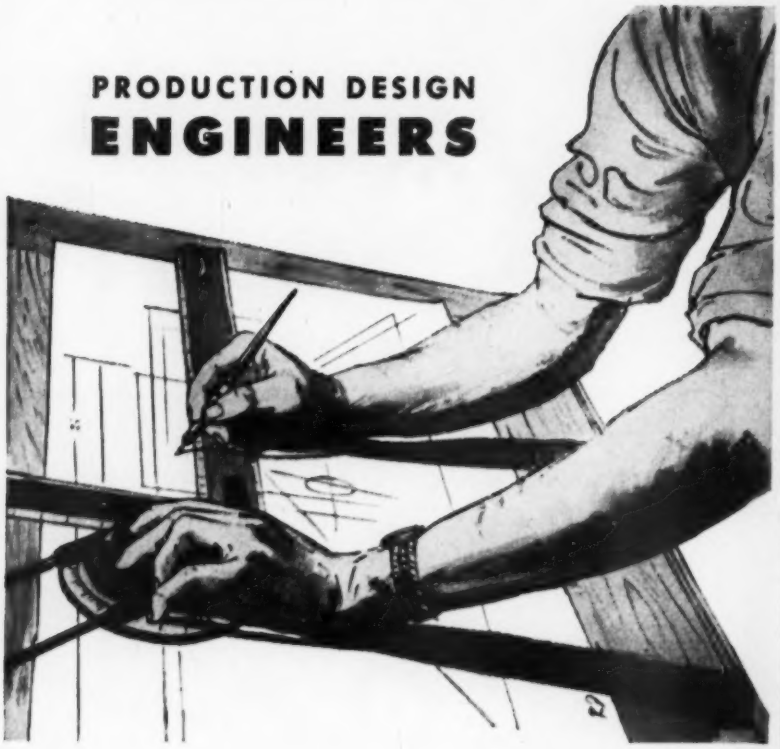

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German Technique Strengthens Sheet

Bonn—Technique that reportedly increases the buckling and bending resistance of any sheet material—metal, plastic, pressed wood or glass—two-fold or more has been developed by Calottan-Technik, Gerhard Holland of Frankfurt, West Germany.

Idea behind new technique: sheet is cast or shaped into a surface pattern of elevations and projections so as to give no preferential axis of inertia. Any cross-section through the material presents a nonuniform stress plane.

Having almost 10 times the bending modulus of flat sheet, according to tests on steel specimens at Staatliche Materialpruefungsanstalt (the government materials testing institute) in Darmstadt, the Calottized sheet would halve materials costs for any desired bending strength.

It is claimed that the new technique also increases ductility, making the material 80 to 100% more resistant to impact.

License negotiations are said to be under way with several German steel and plastic firms and similar talks have been initiated with U.S. companies. So far, trials have been run off using conventional roll mills equipped with one final stage roll having the cup-shaped element pattern.

Two or more sheets can be joined into a single panel, which reportedly increases buckling and bending strength more than 10 times that of similar weight flat-sheet structure. Sheets are joined at mating projections, i.e., a depression of the outside sheet with an elevation of the inside sheet, usually by welding. The double sheet construction dampens vibration and sound, it is claimed, and insulates effectively. The hollow framework between the two sheets can be filled with material.

The sheets are adaptable to conventional shaping methods. The cup-shaped elements, when separate siding sections are joined together, can be made to overlap and interlock, thus reducing the number of required fittings.

Applications possible, according to Calottan-Technik, include construction of flutter-free aircraft wing and tail assemblies.

Harvard Center Will Study Speed, Altitude Responses

A Harvard-Guggenheim Center for Aviation Health and Safety will be established at Harvard University's School of Public Health in Boston. New center will study responses of human body to extreme speeds, altitudes, temperatures and toxic agents in flight and on the ground.

Navy Develops Trainer For Weapons Loading

New type of training aid—a Weapons Loading Trainer—has been developed by the Navy for its North American AJ-2 twin engine attack bomber. Training results with the new device have been so successful that the Navy plans to develop a similar trainer for its Douglas A3D, twin-jet bomber.

The current trainer consists of a simplified AJ-2 cockpit and mocked up partial fuselage and wings. Latter includes a bomb bay section complete with suspension racks used in weapons loading operations. The cockpit contains all the armament selection and power switches and controls used in the actual aircraft.

Trainer simulates the aircraft wiring used for pre-flight check, loading actual or simulated weapons, and post-flight check. It can handle all weapons compatible with the AJ-2.

The device, which includes a malfunction capability, is mounted on landing gear to make it both realistic and mobile. It was designed for use on carriers, in hangars or on the flight line.

The weapons loading trainer was developed under the supervision of Training Device Center's Regional Office and was fabricated by Overhaul and Repair, both NAS, Norfolk.

Navy Will Try Fueling Ship by Probe-Drogue

Probe and drogue refueling, long standard operating procedure in the Air Force and Naval Aviation, will be tried by the Navy on a ship-to-ship basis.

The operation, very similar to in-flight refueling, will involve engaging a nozzle connected to a hose from the tanker ship into the throat of a coupling on the receiver ship. The two units will back together automatically.

Flight Refueling, Inc., has been awarded a contract by the Navy Department for the design and manufacture of the ship-to-ship assemblies.

Canadair Receives $2 Million Contract

Montreal—Canadair Ltd. has received a $2,005,830 contract for aircraft electrical equipment from the Canadian Defense Production Department, Ottawa.

Curtiss-Wright of Canada Ltd., Montreal, at the same time was awarded a contract for aircraft spares amounting to $1,443,936 and Bristol Aircraft (Western) Ltd., Winnipeg, received a contract for repair and overhaul of aircraft totaling $1,220,000.

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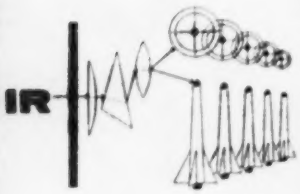

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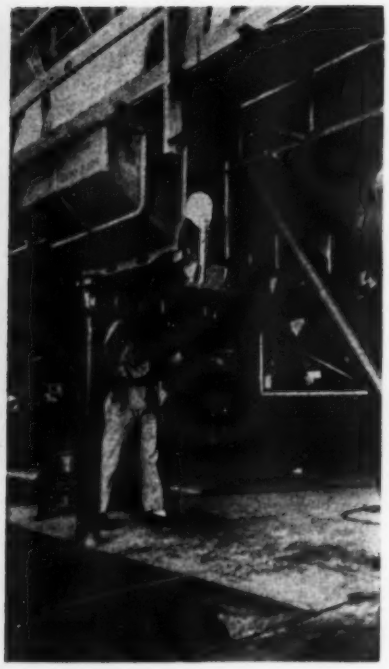
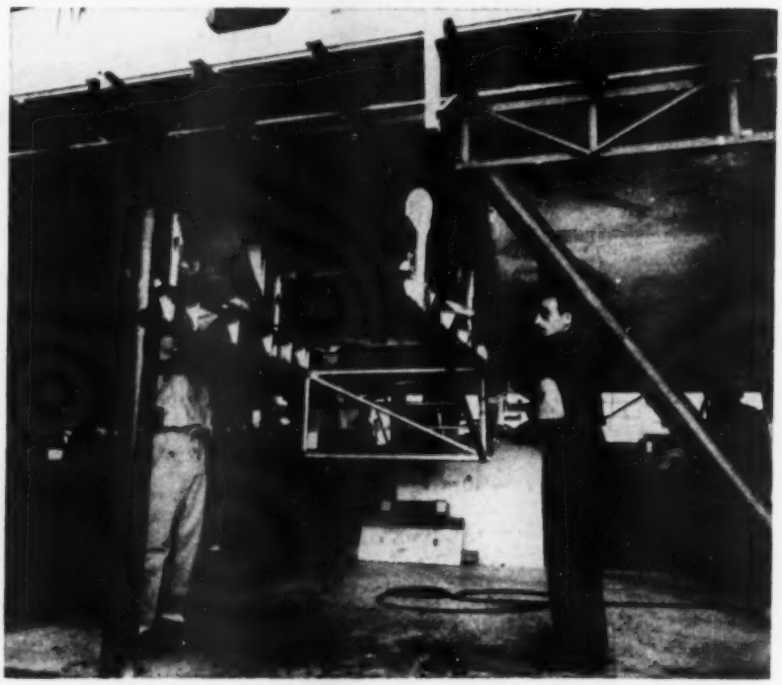
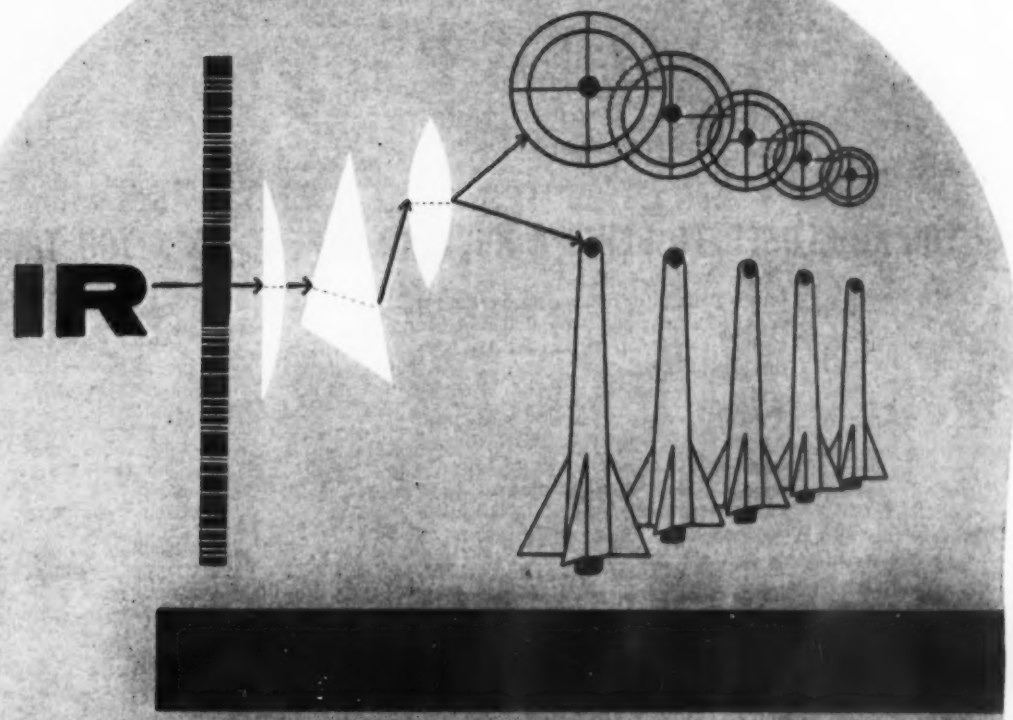


Pre-Loaded Bins Tested

Fast handling of Electra passengers' baggage may result from use of pre-loaded bins under test with mock-up of the turboprop transport. Lockheed Aircraft Corp. and American Airlines workers move a fiberglass bin by dolly to the fuselage (above left). Electrically powered cantilevered hoist is connected to the container, which is raised by push-button action to compartment level (above right). Bin then rolls onto tracks inside the compartment (below), is push-buttoned via a conveyor chain to rear of baggage compartment. System is designed to load or unload complete set of four bins in four minutes. Baggage goes into the bins at ticket counter. Containers are 36 in. wide, 77 in. long and 24 in. deep, weigh 55 lb. empty. American expects the system to help achieve a 10-to-12 minute ground time at intermediate stops for its Electras.





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WHO'S WHERE

(*Continued from page 23*)

Changes

Rolfe Wyer, controller, Pachmayr Corp., Los Angeles, Calif.

Tom C. Clark, director-military sales, Hoffman Laboratories, Inc., Los Angeles, Calif.

Dr. Louis F. Doty, head-aerodynamics dept., Aircraft Armaments, Inc., Cockeysville, Md.

Cliff Anliker, superintendent-manufacturing, Aeronautical Division, Robertshaw-Fulton Controls Co., Anaheim, Calif.

Charles E. Arnold, manager-avionics laboratory, Sylvania Electric Products, Inc., Waltham, Mass.

Paul Burroughs, advertising manager, Air France (North, Central American and Caribbean Division).

Edmund C. Sulzman, general sales manager, Aviation and Ordnance Division, Weatherhead Co., Cleveland, Ohio.

Herbert A. Finke, general manager, Polytechnic Research & Development Co., Inc., Brooklyn, N. Y.

William E. Kurtz, Columbus Division representative (Washington, D. C. office), North American Aviation, Inc., Los Angeles, Calif. Mr. Kurtz succeeds **Robert J. Clark** who is opening North American's European office in Geneva, Switzerland.

Carl W. Bollum, Sr., engineering assistant to the general manager, Guided Missiles Division, Fairchild Engine & Airplane Corp., Wyandanch, N. Y.

Les H. Coates, manager (Dayton, Ohio office), Northrop Aircraft, Inc., Hawthorne, Calif.

John Vlad, manager-newly established New England office (West Hartford, Conn.), Lear, Inc., Grand Rapids, Mich.

Harold A. Tedford, chief-sales operations, Hamilton Standard, division of United Aircraft Corp., Windsor Locks, Conn.

Herbert J. Terry, executive assistant to the vice president-engineering and production, Burton Manufacturing Co., Santa Monica, Calif.

Paul Van Wert, flight operations manager, Hycon Aerial Surveys, Inc., Pasadena, Calif.

Dana P. Kelly, director-public relations The Flying Tiger Line, Inc.

Bob Elliott, sales manager, and **Don Fairchild,** advertising manager, Non-Linear Systems, Del Mar, Calif.

Donald E. Brown, chief engineer, Glendale Division, Consolidated Electrodynamics Corp., Glendale, Calif.

John R. Church, director-aviation sales, AC Spark Plug Division, General Motors Corp., Flint, Mich.

Virgil E. Caldwell, Jr., director-sales and contracts, manufacturing division, Topp Industries, Inc., Los Angeles, Calif.

Louis E. Benitez, director-customer relations (armaments systems), and **Thomas J. Michel,** director-customer relations (electronic systems), Crosley Division, Avco Manufacturing Corp., Cincinnati, Ohio. Also: **Perry Smith,** director-commercial sales.

Warren E. Swanson, manager-research & development, Los Angeles Division, North American Aviation, Inc., Los Angeles, Calif.

Jerry D. Ward succeeds Mr. Swanson as chief-dynamic science.

Philip A. Colman, executive adviser to chief flight test engineer, Lockheed Aircraft Corp., Burbank, Calif.

Belford Brown, manager, San Francisco International Airport, San Francisco, Calif.

A. J. Carah, assistant missiles design engineer, Douglas Aircraft Co., Santa Monica, Calif.

Paul O. Momenteller, division manager-sales and contracts, LearCal Division, Lear, Inc., Santa Monica, Calif.

Frank (Kelly) Achilles, assistant chief engineer, Braniff Airways, Inc.

Dwight C. Hornberger, manager-export administration, Beech Aircraft Corp., Wichita, Kan.

Adm. Selman S. Bowling (USN, ret.), director-communications, Slick Airways, Inc.

John McGraw, chief engineer, Axelson Aviation, Montebello, Calif.

Robert H. Noorduyn, district manager (Dallas, Tex.), Aviation Division, Walter Kidde & Company, Inc., Belleville, N. J.

Thomas Trone, manager-military transportation, Trans World Airlines, Inc.

Joseph E. McKenna, manager-contract administration, Air Cruisers Division, The Garrett Corp., Belmar, N. J.

M. P. Bickley, sales manager-Eastern Division (New York), United Air Lines, Inc. Also: **Jack Misselhorn,** sales manager-Midwest Division (Chicago).

Robert H. Magill, passenger service manager-Midway Airport (Chicago), Continental Air Lines, Inc. Also: **Fletcher Y. Rainer, Jr.,** passenger service manager-Los Angeles International Airport.

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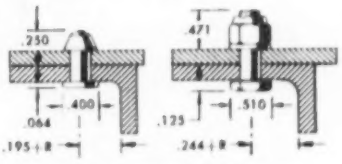
HS15-8	Alum. Hi-Shear Collar	1.32
		10.57 lbs.

NAS464P4A7	Steel Bolt	17.35
AN365D428	Alum. Nut	3.40
AN960PD416L	Alum. Washer	.90
		21.65 lbs.

Even substituting a 40% lighter titanium bolt for the steel bolt, the bolt-nut-washer combination is still heavier than the HI-SHEAR by 4.14 lbs. per thousand pieces.



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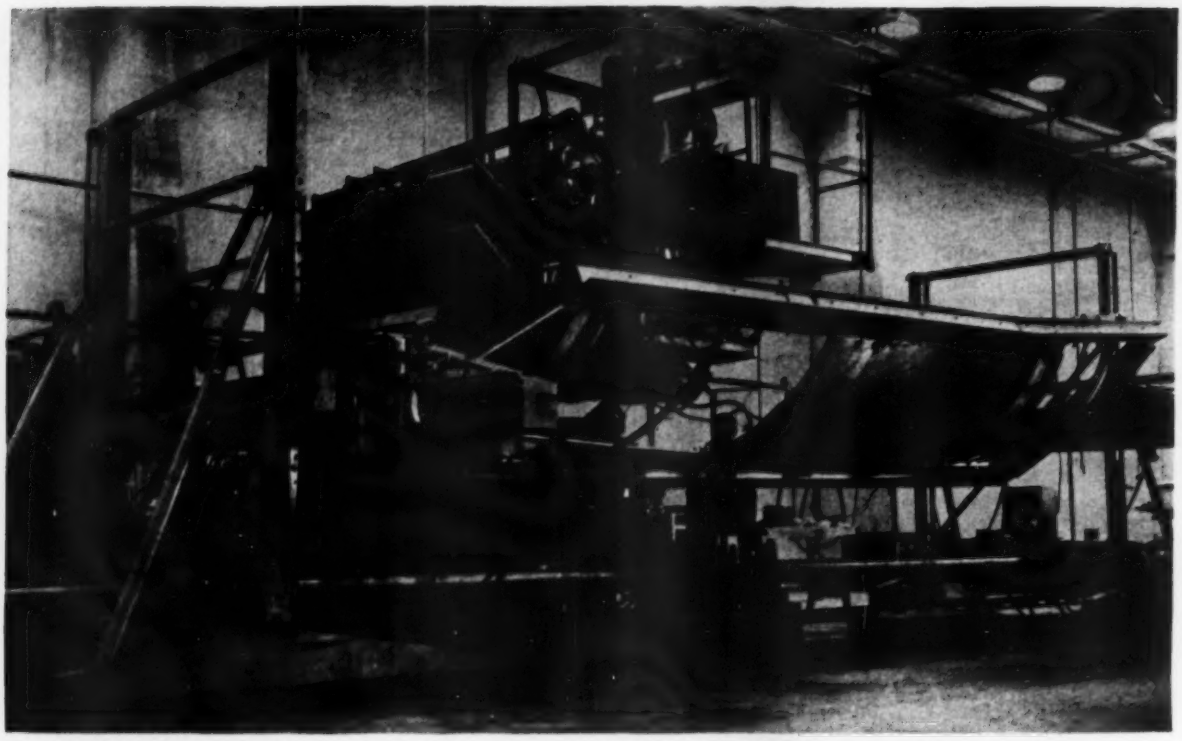

FIRST OF NINE Federal spotwelding machines and automatic positioning tables is installed at Ryan for KC-135 and 707 program.

Ryan Spotwelds KC-135 Fuselage Lobes

San Diego, Calif.—Ryan Aeronautical Co. is carrying out the first spotwelding of large double-countered aircraft panels under automatic positioning and welding control as part of its subcontract for aft fuselage sections of Boeing KC-135 tankers and 707 jet transports.

Totaling 60 ft. in length, the two major sections comprise the largest structure ever subcontracted in the aircraft industry.

Nine Federal spotwelding machines, built to order at $38,000 each, will be used when the program reaches full operation.

They are fed the aluminum skins by means of positioning tables, which in size dwarf the 13½-ft. high spotwelding machines.

Specified By Boeing

Early in the KC-135 program, Boeing specified spotwelding in preference to riveting of skin assemblies to save time and achieve a cleaner,smoother surface with less drag and weight. Originally the plan was to spotweld only the comparatively easy-to-handle single contour skins. But after Ryan received the contract as sole supplier of the aft fuselage sections, Boeing asked Ryan to develop a technique of welding double-contour skin assemblies.

In the beginning, Ryan built an experimental handling device to carry the sections through the welding machines. This employed a jackscrew leveling method, combined with hand positioning.

Four jackscrews were mounted in an overhead set of monorails and attached to the welding frame to hold it in position. The frame, holding the skins, was manually moved from one spotwelding position to the next—a tedious process.

This was not a solution but a comparatively crude stopgap while the long-range production equipment was being developed by Ryan and General Riveters, Inc. of Buffalo, N. Y.

General Riveters, which has concentrated on electrically-operated positioners for riveting, set out to build the first electronically-operated positioning tables for welding machines in the aircraft industry. The company had built tables for Drivmatic riveting of wing structures, using four-directional movement and cam mechanisms for height and level control. However, the intricate configuration of the KC-135 skins required a new system of sensor-leveling to achieve sensitive reactions to electronic commands while guiding panels through the electrodes of the welding machines.

Three of the Federal spotwelders have been installed. They weigh more than 58,000 lb. and at the throat measure 73x54 in. Three-phase unipolar 250 kva. transformer supplies 100,000 amp. Crack-free welding of two thicknesses of .091 in. aluminum sheet can be accomplished with a unipolar schedule.

Black Box

One of the nerve centers of the positioning tables is the sensor-head, a black box with four nylon sensor knobs to control the level positioning of the skin as it comes into contact with the electrogle, on which the sensor-head is mounted. Two of the knobs govern vertical motion, one controlling the right elevator and the other the left elevator of the table. On each end of the carriage, there is an elevator utilizing screwjacks for lift and descent.

On the carriage there is an elevator which raises and lowers a trunion mechanism. This mechanism is also driven in and out of the throat of the

LOWER LOBES of double-contoured aft fuselage sections for KC-135 are built by Ryan under subcontract. Ryan also builds upper lobes.

welder by a transverse drive consisting of a horizontal screwjack mounted on the elevator carriage.

The other two sensor-buttons effect rolling motion by operating a tilting mechanism consisting of hydraulic cylinders on each trunion. These cylinders rotate the trunion and the welding frame in which the skin is mounted.

The two end carriages are interconnected by a longitudinal drive rack used for longitudinal positioning of spotwelds. Transverse positioning of spotwelds is controlled by a transverse drive mechanism.

To eliminate scratching of skins during movement, the panel is automatically raised ¼ in. by electronic control of the sensing unit. This levels the skin assembly ¼ in. above the electrode. Upon command to weld, the skin is automatically lowered in to contact with lower electrode, thus avoiding any rubbing action.

Command Units

A pendant is provided for control of the carriage in manual, increment spacing, and tape command operations.

Manual controls are used for location of the first spotweld, for loading and unloading operations, and other controls requiring individual movement by the operator.

Welding operations are normally controlled by the tape command unit, providing complete positioning in all directions, with automatic interlock between positioner and welder. The increment spacer incorporated in the controls serves a dual purpose:

- **Welding repetitive welds** of equidistant spacing, such as stiffeners on the skins, etc.
- **Assistance in cutting** the tape for tape

INTERIOR OF KC-135 aft fuselage half-lobe (left) shows stringers and bulkheads spotwelded to double-contoured skin sections. Boeing's desire for aerodynamically clean surface on outer skin of the sections (right) led to development of technique. Spotwelds also save weight.

Undergoing U. S. Army evaluation tests including airlifting externally slung cargo, this Marine Corps HOK-1 demonstrates its ability. Shown here carrying a 2500 lb. jeep, it also takes artillery pieces, gas drums, ammo cases and other bulky materiel in stride.

HOK-1 general utility helicopters are already in service with the U. S. Navy and Marine Corps where they are used extensively for search and rescue missions, medical evacuation, personnel transport and cargo carrying.

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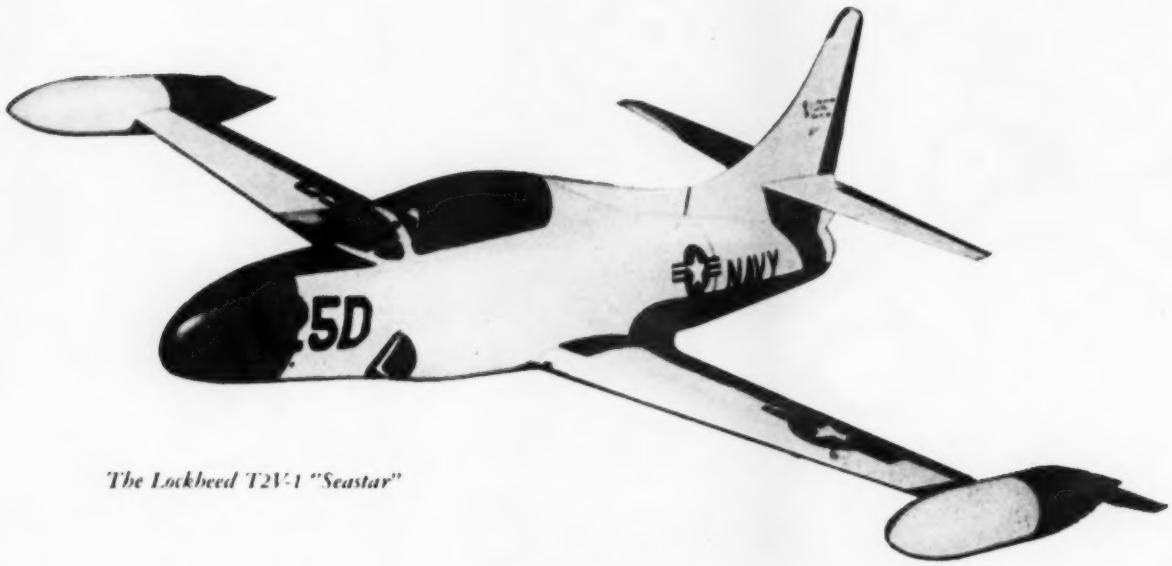
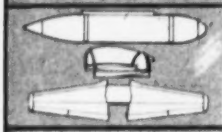


The Lockheed T2V-1 "Seastar"

BEECH BUILDS	
	MA-2 MULTI-PURPOSE VEHICLES
	C-26, MD-3 POWER UNITS
	TANK-WING-MAJOR SUBASSEMBLY SUBCONTRACT PRODUCTION
	BEECHCRAFT T-34 TRAINERS
	BEECHCRAFT L-23 TRANSPORTS
	4-PLACE BEECHCRAFT BONANZA
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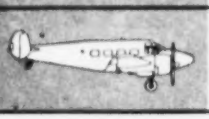	8-PLACE BEECHCRAFT SUPER 18

Since early in 1951 Beech Aircraft Corporation has been building wings for Lockheed's famous T-33 jet trainer. To date, more than 5,000 sets of T-33 wings have been produced along with hundreds of additional wings for Lockheed's F-94C "Starfire" and T2V-1 "Seastar." As further evidence of this continuingly successful subcontract relationship, Beechcraft is now producing the aft fuselage section of Lockheed's new F-104 "Starfighter", the world's fastest fighter airplane.

You'll also find other major components and famous names on Beechcraft's subcontract production lines . . . canopies and windshields for Convair's F-102 delta wing fighter . . . fuel tanks for Republic's F-84F fighter-bomber . . . and major sub-assemblies for McDonnell's F-101 supersonic fighter. We're proud of the trust and confidence these outstanding companies have placed in Beech craftsmanship.

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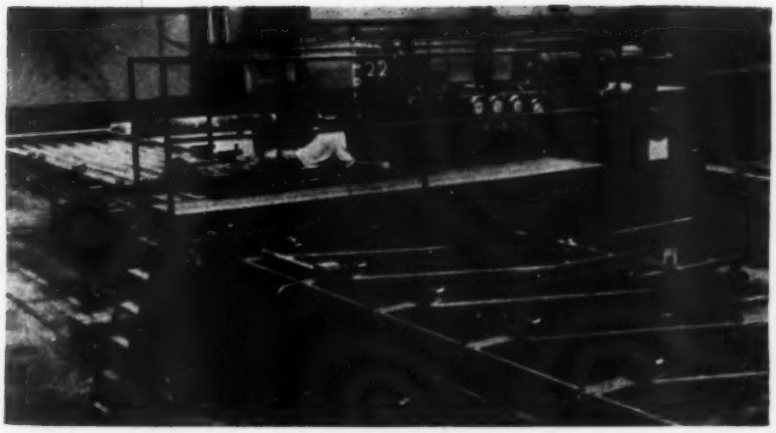

FOR SPOTWELDING single-contoured skins under automatic control (top), Ryan uses new Sciaky spotwelding machines with special positioning control. Operator lies prone as panels are fed through electrodes. Single operator can use this spotwelding machine (bottom) and watch both sides of the panels through a television monitoring screen.

command operations, including spotwelds of varying distances.

To follow the curvature of the skin, a tracing head is mounted adjacent to the upper electrode of the welder. It profiles against the edge of doublers and stiffeners to provide uniform edge-distance spacing. This operation permits two-directional movement—one being automatically controlled by the tracer. The other, by tape command, gives predetermined spot spacing positioning.

The punch-hole tape utilizes seven command channels, providing directional and spacing control. Ten different double-contour skin assemblies are spotwelded each with their own tape, which is in direct linkage to the carriage through a Selsyn positioner.

For the single contour skins, Ryan first built a manually-operated positioner consisting of a flat table designed originally for roll-spotwelding and providing longitudinal index spacing. For spotwelding, a manual space was built for the table. This is controlled by a spacing bar attached to the side of the table; a spring-loaded ball fits into a notch in the spacing bar and the indexing is performed notch to notch by hand.

Ryan now has two such tables for straight line spotwelding by Federal welders, of lesser dimensions than the double-contour machines.

In addition, two General Riveters panel tables have been installed for

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single-contour skins. These index both longitudinally and transversely with a combination of electrical and hydraulic controls. One table operates with a Sciaky welder that has an exceptionally deep throat for its type—70 in. The other functions with a Federal welder with throat dimensions of 60 in.

These single contour positioning tables incorporate a counting system, whereby the count is a predetermined number of ⅛ in. increments, the space between the spotwelds being multiples of these increments.

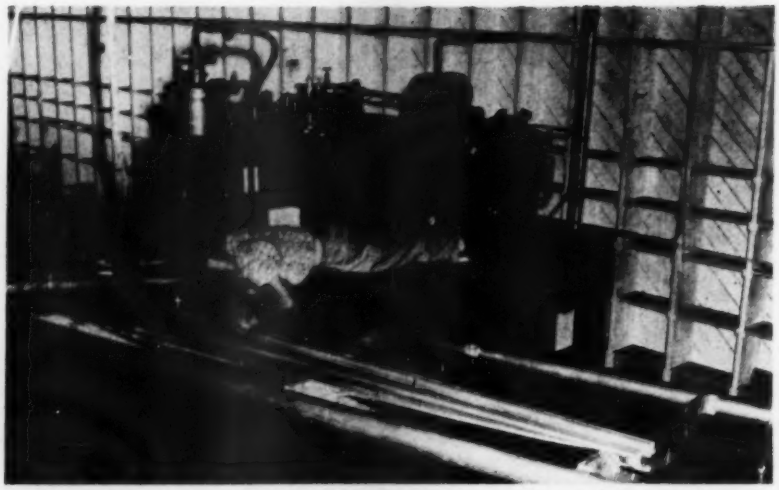
A photoelectric cell counts light spaces. When the predetermined number of light spaces has passed through the counting relay, the movement is stopped, automatically firing the welder. A conventional-switching system is used for longitudinal, transverse movement.

On the flat positioners for single-contour skins, a television camera is placed beneath the table as an inspection aid to determine whether the spotweld is maintaining required quality. The receiver is in front of the operator. On double-contour skin positioners, television cameras may be used to assist the operator in controlling directional movement.

Handling of the aluminum skins and components of the size demanded in the KC-135 and 707 project is a critical matter. The primary problem is maintaining the surface cleanliness necessary to attain the welding strength and quality required to meet structural and appearance specifications. Also critical is the time limit between etching and welding. Welding must be performed within 24 hr. after etching to insure uniform cleanliness and electrical resistance for spotwelding current.

The massiveness of the parts aggravates the handling problem. Skins must be protected from fingerprints, oil, dirt, etc. White gloves, special handling fixtures, coverings for parts while awaiting welding, and close control through date-stamping are among techniques utilized.

Approximately 77,000 spotwelds are required to join skins to skins, skins to doublers and stringers, and bulkhead components together in the fuselage sections.



EARLY RYAN experimental work with single-contour welding used this machine and table. Operator lay prone over the equipment.

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Aircrafts' Who's Who Reports

A cross section of the Who's Who in the aircraft industry—including Douglas, Allison, Fairchild, Grumman, Martin, Republic, Canadair Ltd., Pratt and Whitney among a host of others — is reported to have reduced engine wiring time as much as 66%. This saving is effected by the use of the new Robinson Wire Twister, an improved model of the ones that have seen service with the army, navy and airforce since 1943. Improvements include the exclusive diagonal jaw design that permits easier access to hard-to-reach areas, and clamps a vice like grip on the wire by pulling it into a 30° bend thus delivering added leverage for twisting.

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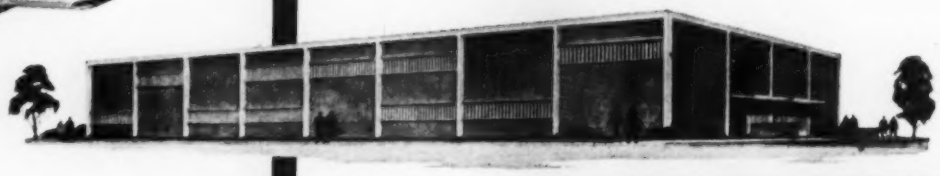

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Ion, Photon Power Space Travel Hope

San Diego—Difficult space travel problems spanning the broad regimes of propulsion, re-entry, human factors, tracking and communications, environment and measurements, and orbits were analyzed in this country's first astronautics symposium, sponsored here by Air Force Office of Scientific Research and Convair Division of General Dynamics Corp.

Interest of 500 scientists and engineers from the military, industry and universities indicated that it probably will become an annual event.

Propulsion system, probably one of the most critical elements in the astronautical vehicle, will determine whether space travel is possible and how far this travel will be, according to Dr. William Bollay, Aerophysics Development Corp. president, and panel leader of the session on propulsion.

Photon Rocket

An indication of how far thinking has progressed in the propulsion regime is the conception of the photon rocket, which was discussed broadly by Dr. Ernst Stuhlinger, chief of Research Section, Guidance Control Branch, Redstone Arsenal.

While it is conceded by scientists that the creation of the photon rocket with the necessary large thrust-to-weight ratio is not within the range of present technical feasibility and is now only an interesting mathematical exercise, this propulsion system indicates horizons of space travel out of reach for "classical" designs of space ships. Stuhlinger related that thorough studies on mechanics of photonic propulsion systems had been made by Prof. E. Sanger in Stuttgart.

Assumption is that photons are created by direct, total and controlled conversion of matter into radiation energy according to the fundamental Einstein equation $E=mc^2$. If the entire mass of the propellant can be converted into energy according to the equation, the energy content of matter is 100 billion times higher than the chemical energy of conventional propellants, referred to the same mass.

Characteristic data of the photon spaceship, revealed by Stuhlinger, showed that for a trip half around the earth the mass ratio (starting mass to final mass) would be 1.00007. Ship time would be 47 min. Figures for a trip to the moon would be 1.0003 and 3.5 hr., respectively; planet trip, 1.006 and 2 days; trip to Alpha Centauri, 20 and 3.6 years. (A constant acceleration of 1G to the midway point, and a subsequent deceleration of same magnitude was assumed.)

Symposium Coverage

Material for this report on the three-day astronautics symposium in San Diego, sponsored jointly by Air Force Office of Scientific Research and Convair Division of General Dynamics Corp. was gathered by Irving Stone and Richard Sweeney, members of Aviation Week's West Coast bureau, who attended the symposium sessions and interviewed panel members.

While the propellant mass needed for a voyage as far as the planets would be negligible, Stuhlinger said, the necessary mass ratio of a photonic ship capable of a round trip through the universe would require, for an empty mass of 600 tons, a takeoff mass equal to that of our whole earth.

"Even though a photonic spaceship with those features cannot be accomplished by technologists which will be at our command within a foreseeable time, they are very interesting as speculations because they give an impression of where the limits are set in principle by the basic laws of physics as we know them today," Stuhlinger declared.

Chemical Power

First trip through space probably will be made with a chemically powered vehicle. (Bollay says that there will be improvement of 50% in efficiencies of propellants in the coming decade.)

Nuclear or solar-powered ships, either heating a light gas or accelerating ions electrically, may become competitive as soon as the systems are developed to a perfection comparable to that of chemical ships, Stuhlinger said.

Interest in ion propulsion systems was revealed recently in AVIATION WEEK (Nov. 26, 1956, p. 57; Feb. 18, p. 37). One possible scheme for an electrically propelled spaceship was outlined by Stuhlinger.

Primary power source is a nuclear reactor. Electric power is generated by means of a turbo-generator with radiation cooler. Alkaline metal, such as rubidium or cesium, which ionizes easily upon contact with incandescent platinum, was chosen as the propellant. Ions and electrons are expelled at equal rates through thrust chambers. Recombination of ions and electrons immediately behind the thrust chambers eliminates space charge effects. If the ions were not neutralized they would form a cloud of charges behind the ship, act back to counteract thrust.

Propulsion systems such as this could be applied to a spaceship having a 730-ton takeoff weight and a payload of about 150 tons. It would be capable of traveling to Mars in about 400 days and would require about 300 days for the return trip, Stuhlinger said. The entire trip, with stay time, might take about 3½ years, he said. Optimum exhaust velocity of the ions would be 80 to 100 km./sec.—about 30 times higher than for chemical rockets. Optimum mass ratio would be about 2 to 1. Acceleration of the ship would be low—about .0001G.

Commenting on production of ions, Stuhlinger declared that to be suitable for a spaceship, the system would have to be as simple as possible and have few auxiliary devices to promote reliability. The ion source, he said, should work with an efficiency of 95-100%. An ion source developed in the laboratory, he revealed, has worked at an efficiency of 98%.

Stuhlinger indicated that the ion propulsion system could be built with techniques known today.

Methods are lacking which can make a copious quantity of ions, according to Dr. Y. C. Lee, head of the Study and Applied Research Dept., Liquid Engine Division, Aerojet General Corp. It is important, he indicated, that basic research should be conducted on methods of obtaining high yield of ions; means for separation of positive from the negative ions and practical methods of acceleration.

Methods of producing ions in the gaseous state, he said, included ionization by collision, by electromagnetic radiation, nuclear reaction, chemical reaction, use of shock tubes, and surface films in an intense field.

Combustion Dynamics

Commenting on chemical rockets, he indicated that component improvement in reliability, weight minimization, and system integration require additional effort. For the high thrust rocket engines required for astronautical travel, combustion dynamics will be a major problem area.

Lee declared that experimental research was needed in the suppression of high frequency oscillatory combustion by baffles, interaction of shock waves and atomized propellants, structural coupling, bubble formation due to axial vibration, spectroscopic measurement of gas components, and effect of mounting systems.

Basic research on high-density plasmas, a mixture of gas and electrically charged particles, such as ions and electrons, at

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continuous temperatures exceeding 10,000K, is being conducted by Giannini Research Laboratory, Santa Ana, Calif. Aimed at determining what occurs in a gas flow with high energy contact, the work is being performed under contract with AFOSR. This experimental research is deemed necessary to discover what are the fluid dynamic laws governing the flow of partially ionized gas.

Depending on experimental results and theoretical interpretation, the use of the plasma may be related to propulsion for space travel by bridging the gap between the chemical rocket and the pure ion propulsion system, Gabriel M. Giannini, president of the laboratory and of G. M. Giannini & Co., Inc., told AVIATION WEEK.

Immediate practical application of the ionized jet (plasma) is in an experimental high-temperature, high-velocity, low-density wind tunnel for simulating re-entry conditions and testing shapes and techniques associated with the re-entry problem. Such a wind tunnel is now being assembled at the laboratory. With a simple ionized gas jet, temperatures may be obtained which are at least twice those realized with the best solar furnace, Giannini said. This opens the door to materials research with temperatures not obtainable by other means.

Using various gas mediums and energy concentrations, power as high as 50 kw./sq. m. of nozzle areas has been absorbed.

Associated with Giannini in the research activity is Dr. Pol Duwez, California Institute of Technology, Prof. Leon Brillouin, well-known physicist, and Lt. Gen. Laurence C. Craigie, (ret.) a director of the company.

General Electric Co. Missile and Ordnance Systems Department in Philadelphia is now operating a water stabilized electric arc for producing a high temperature ionized plasma jet in an evacuated tunnel for simulating ICBM nose cone re-entry conditions. Controlled temperatures in the tunnel have been achieved as high as 25,000F. General Electric is working with the University of Chicago's Midway Laboratory on this project.

Evaluation of the relative merits of one propulsion system over another will require examination of many factors, some still unknown, according to George P. Sutton, chief, Preliminary Design Section, North American Aviation, Inc. For this reason it is not possible to make a general statement now concerning the optimum powerplant for space travel. The vehicle probably will be a multi-stage ship and mount more than one type of powerplant, each used for a specific portion of the flight. A relative evaluation of the optimum powerplant, he indicated, will require evaluation of missions.

Ion Power Contract

In his introductory remarks at the opening of the astronautics symposium, Brig. Gen. H. F. Gregory, commander, Air Force Office of Scientific Research, said:

"I am delighted that such companies as Convair are working on ion propulsion; that Martin's RIAS division is working in entirely new fields of science, and that Fairchild has established a forward-thinking propulsion group."

USAF previously had revealed that two small study contracts for such a system had been let, but did not reveal the company (AW Feb. 18, p. 37).

Analysis of a hypothetical descent of a manned 5-ft. spherical earth satelite from a circular orbit about 500 mi. high, was presented by Alfred A. Eggers, Jr., Ames Laboratory research scientist, National Advisory Committee for Aeronautics. It was concluded that a vigorous young Air Force man "ought to be able to do it."

The sphere would weigh 630 lb. and would mount fins on its aft portion to keep the body axis aligned with its motion. It would decelerate from the 500-mi. height down to a 50-mi. altitude in about three revolutions of the earth. The orbit could be maintained circular by use of a rocket motor to retard the vehicle in a direction opposite to its direction of motion.

At about 50 mi. the vehicle would begin to drag significantly in the atmosphere, and begin to heat. Occupant of the sphere would have to be protected from this heat, which would be about 3,000 Rankine at approximately 40 mi. altitude. There is a good chance of getting laminar boundary layer flow where heating rates are greatest.

By the time 35,000 ft. was reached, the speed would be reduced to 400 fps. and a parachute could be deployed to bring the sphere's occupant to the ground.

Possibilities of using aerodynamic lift to control aerodynamic loads and heat transfer to the vehicle were outlined by Prof. Antonio Ferri, Polytechnic Institute of Brooklyn. His proposal concerned decelerating the re-entry vehicle by using lift and drag to keep it at high altitude where air density is low and, therefore, aerodynamic heating is low.

Analysis of the radiative equilibrium temperature of an earth satellite sphere descending through the atmosphere was outlined by Fred R. Riddell, senior research engineer, Avco Research Laboratory. It was pointed out that, using proper design precautions, the Vanguard satellite might survive re-entry intact. Two schemes were proposed for re-

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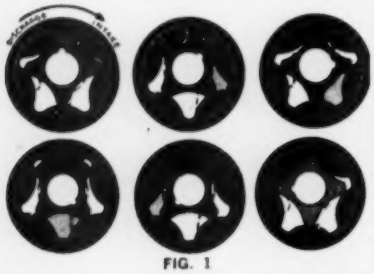

FIG. 1

Low relative speed and closely held clearances between the two Gerotor elements mean high mechanical efficiency is maintained.

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covery: deceleration at high altitude by using a light, high drag body and getting rid of heat input by radiation or by deceleration at lower altitude and soaking up heat with a sink.

Possible serious consequences of turbulent boundary layer flow over an entry vehicle, since turbulent layer heat transfer rates can exceed laminar rates by a factor of about 10 to entry speeds, were noted by E. Van Driest, chief scientist, Missile Development Division, North American Aviation, Inc. He gave results of his experiments using liquid nitrogen-cooled cones in a supersonic wind tunnel, and showed that decreasing the surface temperature or cooling the cone delayed onset of turbulent flow significantly. Van Driest also indicated that sensitivity of the boundary layer to surface roughness apparently decreased with increasing Mach number.

A better appraisal of the cosmic ray hazard to man requires elaborate experimentation with artificial satellites to study the extra-atmospheric intensities of the heavy component and the reaction of test animals to it, according to Herman J. Schaefer, research physicist, Naval School of Aviation Medicine. Discontinuance by the Air Force of its biological balloon experiments, while it may have been done in deference to more urgent work, is lamentable, Schaefer declared. He hoped that indifference to comic ray hazard is only a temporary affair.

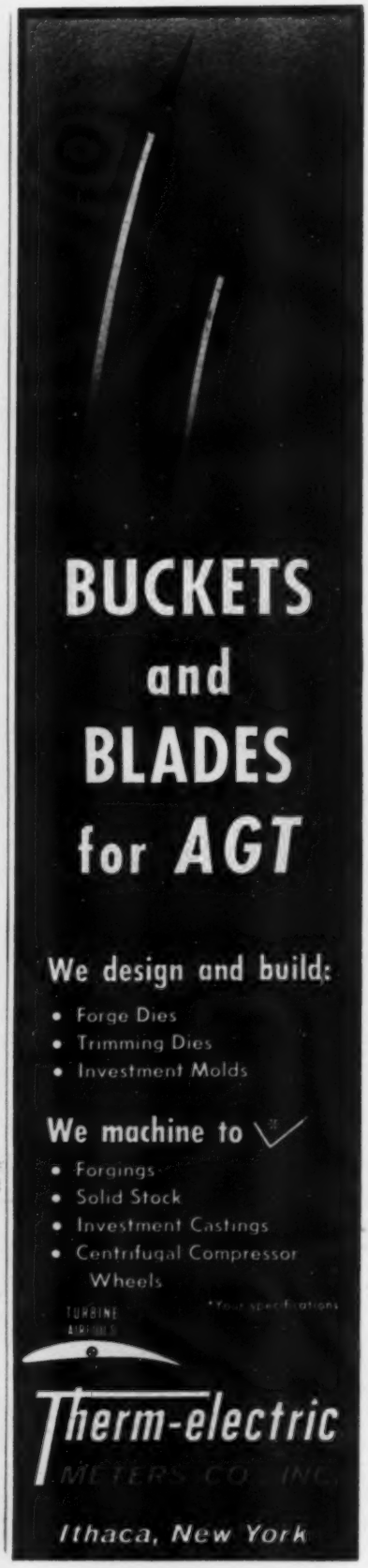
Cosmic Ray Exposure

Evidence exists that cellular destruction results from exposure to primary cosmic rays, it was pointed out. Photos were shown of changes to mice (longer tail and hair) as a result of exposure to primary cosmic rays at 90,000 ft.

Schaefer declared that if a "flying population" were exposed to the region of 120,000-ft. altitude for 1,000 hr. per year, the number of genetic defects would be doubled, as a result of exposure to cosmic radiation dosage.

The unusual flare from the sun about a year ago indicates that this body is one of the primary sources of cosmic rays. This flare produced a 35-fold increase in cosmic ray particles, it was pointed out.

A study exercise with three missions, including a flight to an altitude of 200 mi., manned satellite flight for 100 trips around the earth, and a flight around the moon, was suggested by Col. Paul A. Campbell, special Assistant to Commander for Medical and Bioscientific Research, AFOSR. After designers and engineers had supplied a frame of reference for each of the missions, including duration, crewspace, weight allowances, etc., working groups of experts could be formed in aviation



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medicine, physiology, psychology, human engineering, etc., to establish requirements, assemble knowledge and determine gaps.

Facets listed by Campbell for consideration included oxygen, fluid, food, and air conditioning requirements, removal of waste products, optimal metabolic rates, use of drugs which keep metabolic rates low and would not interfere with efficiency, crew weight reduction before flight versus starting with a store of body fat glycogen.

Three aspects of re-entry into the atmosphere are of particular interest to Holloman AFB's Aeromedical Field Laboratory, according to Maj. David G. Simons, USAF(MC), chief of the laboratory's space branch. These are:

- **Safe recovery** of recorded data from a non-recoverable ICBM or satellite carrying biomedical experiments.
- **Human factors** aspects of re-entry into atmosphere in terms of heat, acceleration, and performance capability.
- **Valid escape concepts** beyond the atmosphere and at orbital velocities.

A first step toward experimental investigation of these problems is being taken by dropping test objects from balloons at 90,000 to 120,000 ft.

Details of a vacuum chamber with an environment capability of 200-mi. altitude were revealed by Richard Roche, Research Dept. chief, Litton Industries. According to Roche's information, top altitude simulated in low pressure chambers in operation now is 300,000 ft.

Pressure Chamber

Initial section of the chamber, measuring 8 ft. in diameter and 15 ft. long, is scheduled for completion this spring. Built under contract with AFOSR, the chamber is projected for immediate application in research and testing with vacuum tubes. However, space simulation capabilities of the unit will bring its adaption for runs with men as well as equipment. The chamber is also projected as an air lock for a larger vacuum chamber which will measure 15 ft. in diameter and 35 ft. long.

Key consideration in the operation of the chamber will be protection of the man in the event of rupture of his specially developed pressure suit or faceplate. With such failure, he would remain conscious for only about 5 sec., and would suffer severe physical injury, perhaps death in 90 sec. Emergency features will allow the chamber pressure to be raised to the equivalent of 25,000 ft. altitude in one second.

Meteoric risk to space vehicles was discussed by Dr. Fred L. Whipple, director of Smithsonian Astrophysical Observatory and astronomy professor at Harvard. It has been decided that there are a greater number of meteors

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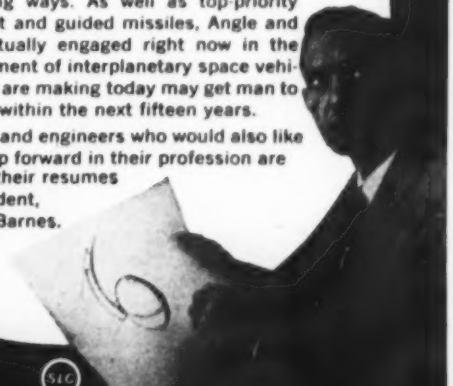

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Henry Rempt (second from left), head of the Electronics and Armament Systems Division, discusses problems inherent in the application of large electronic sensing devices to aircraft with David Morrissey, A.E.W. Systems Specialist, Harold Held, Data Links Specialist in the Advanced Techniques Group, and Nelson Harnois, head of the Electronics and Armament Systems Engineering Department.

Lockheed expands electronics division

■ To keep pace with its ever-increasing emphasis on electronics, Lockheed has expanded and centralized research and development activities under the Electronics and Armament Systems Division. The Division is under the direction of Henry Rempt.

Responsibilities of the Division include originating and developing complex electronics and armament systems for all new Lockheed aircraft.

A number of technical management positions for Electronics Systems Engineers has been created. The positions will appeal particularly to those who seek an extremely wide range of assignments.

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than previously believed, the frequency having been increased by a factor of seven, and that they are low-density comet fragments. Meteors were characterized as the large type which could puncture the skin of a vehicle and smaller particles which could erode the surface material. This erosion, it would seem, might affect the reflective qualities of the material, thus affect the heat of the body. Chance of a meteor impacting on the satellite is one in four days.

Model Atmosphere

Results of recent studies of the upper atmosphere between 90 and 300 km., which includes the ionosphere, a region of importance to long-range communications, were revealed by Dr. H. K. Kallmann, UCLA Institute of Geophysics and consultant to the Rand Corp.

Dropping simplified assumptions made in evaluating the theory of the ionized layer formation and using a new "model" atmosphere worked out with Dr. Newell of the Naval Observatory Laboratory, Dr. Kallman said that two important conclusions can be drawn:

- **Ionosphere** does not consist of ionized layers, but is a continuously ionized region.
- **True height** of radio wave reflection is considerably lower than the apparent height, except for the bottom of the E-region.

Aspects of moon rocket studies were presented by Hans A. Lieske, head of Flight Mechanics Group, Rand Corp. Just to impact a rocket on the moon, would permit an allowable error of ±40 fps. and an angular error of 4 deg. with an initial velocity of 35,000 fps. at an altitude of 350 mi.

Moon Accuracy

To hit a moon location within 100 mi., an accuracy of ±2 fps. and .01 deg. would be required. To make the body a satellite and obtain a 100-mi. accuracy in initial orbital altitude at the moon, variance should not exceed ±2 fps. and be within .01 deg. of angle. Initially it would require a tolerance of ±¼ fps. and ±.01 deg. to send a vehicle to the vicinity of the moon and bring it back to earth with a 1,000-mi. landing uncertainty in the return point.

This would introduce difficulties in recovery, considering the amount of ocean area.

In his discussion on cislunar space, Krafft A. Ehricke, chief, Pre-Design and Systems Analysis, Convair Astronautics Division, revealed that the region of 7 to 10 earth radii is an ideal point for spaceships to fly from earth, refuel or perform other functions, then take off for remainder of the flight. Also, incoming spaceships could come to a satellite at this point, transfer people and cargo to another vehicle for trip to earth, then travel away with new load to another planet with minimum energy requirements to escape from the earth field.

This is a region where perturbations are at a minimum, but to use it orbital accuracy requirement is at a maximum.

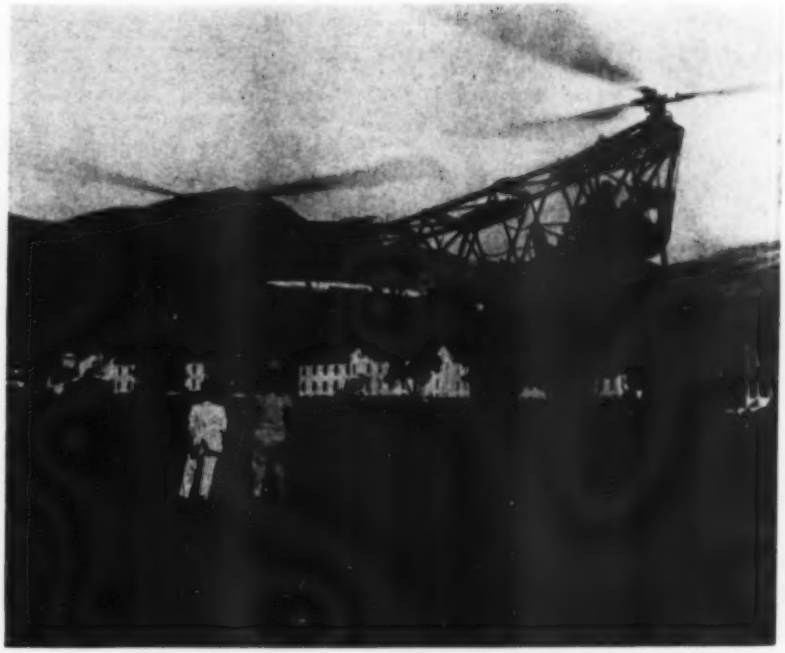
Communication problems associated with space travel were analyzed by Dr. James Marsh, vice-president, Systems Laboratories Corp.

Marsh believes that no major technical breakthroughs are needed to obtain adequate communications but, rather, a refinement of known techniques and equipment.

Taking advantage of space characteristics, a large antenna could easily be extended from the ship after it leaves the atmosphere, because of the absence of loads.

Transmitter power would be a problem, but recent Maser findings present an increase of about 30 db. in transmitter output without any increase in power. In figuring growth, ratio of about 7 lb. structure and power equipment is required in aircraft for every pound of radio gear added.

Spaceship growth may approximate at least 100 lb. to 1 lb., or as high as 1,000 lb. to 1 lb.



Helicopter Carries Missile

Vertol HRP-1 helicopter is transporting Nike missiles to Angel Island, a Nike launching site in San Francisco Bay. The helicopter is shown here at nearby Fort Baker, take-off point for the missile ferrying operation. Army has hired Rick Helicopters, Inc., South San Francisco, to operate a helicopter shuttle service for freight and passengers between several Bay Area army installations.

AMC Contracts

Wright-Patterson AFB, Ohio—Following is a list of unclassified contracts for $25,000 and over as released by the Air Materiel Command.

International Business Machines Corp., New York City, N. Y., $2,201,677 for directional information center.

Northrop Aircraft, Inc., Hawthorne, Calif., $1,881,493 for incorporation of flight test instrumentation changes.

Goodyear Aircraft Corp., Akron, Ohio, $1,279,496 for facilities for TM-61B missile guiding system.

North American Aviation, Inc., Downey, Calif., $1,082,670 for maintenance of USAF Plant 16.

Air Logistics Corp., Pasadena, Calif., $2,450,000 for trailers, air logistics Model W, spare parts and data.

Lockheed Aircraft Corp., Marietta, Ga., $2,046,000 for performance of A. F. Plant 6.

Bendix Aviation Corp., Bendix Radio Div., Baltimore, Md., $9,927,631 for radar set groups.

General Electric Co., Aircraft Gas Turbine Div., Cincinnati, Ohio, $53,414,557 for J79 jet aircraft engines and data.

Garrett Corp., AiResearch Manufacturing Co., Phoenix, Ariz., $7,723,000 for air gas turbine compressors.

Avco Manufacturing Co., Lycoming Div., Stratford, Conn., $2,000,000 for funds for T53 engine.

General Electric Co., Syracuse, N. Y., $4,594,905 for 8MH tropospheric scatter systems.

Ronan & Juntzi, Inc., Marshall, Mich., $1,428,288 for liquid oxygen storage tanks.

International Business Machines Corp., New York, N. Y., $3.1 million for product improvement and service test program for bombing navigational system.

Sperry Gyroscope Co., Great Neck, L. I., N. Y., $2,727,517 for radar set.

Jack & Heintz Inc., Cleveland, Ohio, $1,681,893 for generators.

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Navy Contracts

Following is a list of unclassified contracts for $25,000 and over, as released by Navy Contracting Offices:

NAVY DEPARTMENT BUREAU OF AERONAUTICS, Washington 25, D. C.

Fairchild Engine and Airplane Corp. (Fairchild Engine Div.) Deer Park, Long Island, N. Y., J-44-R-20 engines, NOas 56-799-F (PD-41-970-56), 92, $1,647,559.

SUPPLY DEPARTMENT, Naval Air Material Center, Naval Base, Philadelphia 12, Pa.

A. Roeblings Sons Corp., 640 S. Broad St., Trenton 2, N. J., Wire Rope, 6X19 performed high-strength, uncoated, for aircraft launching and arresting. Mil Spec MIL-W-6015A (ASG) N156-33577 (IFB 156-14-57) (156/20026/57B), 78000 ft., $25584.

AVIATION SUPPLY OFFICE, 700 Robbins Avenue, Philadelphia 11, Pennsylvania.

Pesco Products Division, Borg Warner Corporation, 24700 N. Miles Road, Bedford, Ohio, Maintenance Parts (33/2118-49/53), Vartous, $183930.

Turco Products Incorporated, Terminal Annex, 2649, Los Angeles 54, Calif., Compound (JD-383/29081-60G) 4/1/57/AERO), Vartous, $39069.

The Cornelius Company, 550 39th Avenue, N. E. Minneapolis 21, Minn., Aircraft assemblies (JD-383/2110-1988/52/AERO, Vartous, $59821.

Army Contracts

Following is a list of unclassified contracts of $25,000 and over as released by Army Contracting Offices.

THE ARMY SIGNAL SUPPLY AGENCY, 225 S. Eighteenth St., Philadelphia 3, Pa.

Nanassi Co., Inc., West New York, N. J., handle, handset, contract No., 73481 (IFB-SC-36-029-56-1357-58) 13350 ea, $29163.

Gilfillan Bros., Inc., Los Angeles, Calif. Radar Set (AN/FPN-33) Modification, contract no., 71916 (PD 02-790101-01) 7 ea., $343793.

Raytheon Mfg. Co., Waltham, Mass., Electron Tube, type 2K 45, contract No. 73372. (PR SC-36-039-56-11003-56) 7816 ea., $233758.

Landers, Frary, and Clark, New Britain, Conn., Radiosonde Receptor, AN/AMR-1 (Equipment installed in acft. to record radiosonde signals from airborne radiosondes) contract no. 73367 (PR SC-36-039-56-11005-56), 102 ea., $233758.

Radio Corp. of America, Harrison, N. J., Electron Tube, type 5693, Contract no. 72869 (PR 57/866-25969.

General Instrument Corp., Newark, N. J., Radiosonde, AN/AMR-1) Equipment installed in acft. to record radiosonde signals from airborne radiosondes) contract no. 73367 (PR SC-36-039-56-11005-56), 102 ea., $382027.

General Dry Batteries Co., Lakewood, Ohio, Dry Battery BA-70 Contract no., 72021 (IFB SC-36-039-57-59-57), 5751 ea., $51035.

LOS ANGELES ORDNANCE DISTRICT, 55 S. Grand Ave., Pasadena, Calif.

North American Aviation Inc., Canoga Park, Calif., engine actuating servo-cylinders and servo drive assemblies job, $27639.

USAF Contracts

Following is a list of unclassified contracts for $25,000 and over, as released by Air Force Contracting Offices:

WARNER ROBINS AIR MATERIEL AREA, Robins Air Force Base, Ga.

Hughes Aircraft Co., Florence & Teale Sts., Culver City, Calif., Base antenna applicable to AN/APG 37 System. (IFB 390), 343 ea, $38862.

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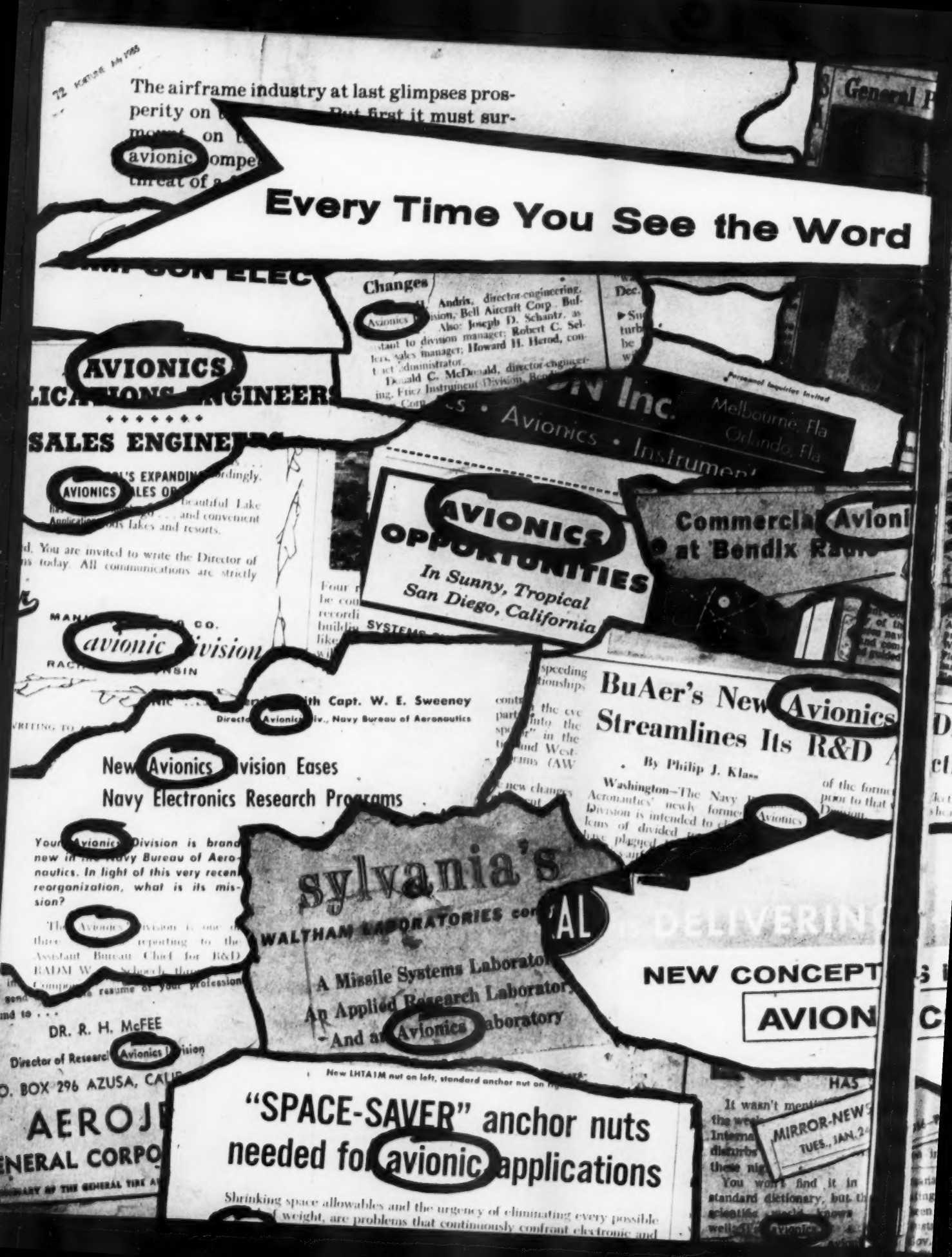
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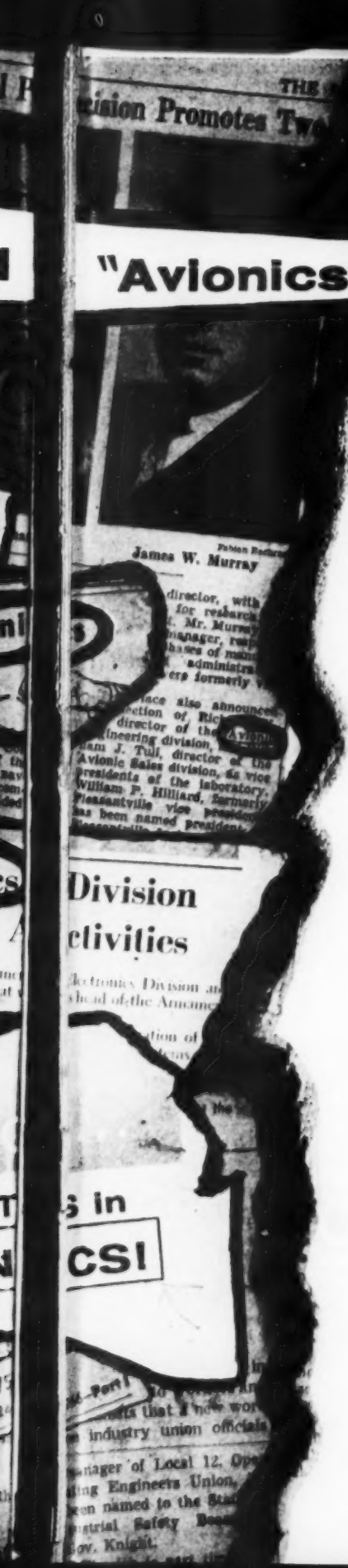

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Francisco, Calif., Repair and/or modification of propeller assemblies (PR 1735182), Job, $130176.

Hughes Aircraft Co., Culver City, Calif., Light Filter assy, modification of kits for E5 FCS (PR 681032) $81231.

Ingersoll-Rand Co., 1700 Third Avenue, South, Birmingham, Ala., compressor, reciprocating, gasoline engine driven, 3500 PSI, Type X MC 1A (IFB465), 854 ea., $2467172.

AC Spark Plug Div., GMC, Flint 2, Mich., (Place of performance 1925 E. Kenelworth Place, Milwaukee, Wis.). Repair and modification of A-1A BNC components (PR 735055) $9849784.

Joy Mfg. Co., 900 Woodland Ave., Michigan City, Ind., Compressor, reciprocating, electric motor driven, 3500 PSI, type MB1, (IFB 467), 74 ea, $266881.

Decker Aviation Corp., 1361 Frankford Avenue, Philadelphia 25, Pa., Repair and modification of vertical gyros, SL 5200-221382 (PR-735-030), 1420 ea., $173311.

Aero-Products Operation, GMC, Dayton 1, Ohio, Spare parts for A422-E2 propellers, $63851.

Specialties, Inc., Skunks Misery Rd., Syosset, L. I., N. Y., repair and modification of angle of attack detector (PR-735034), 174 ea., $35702.

National Cash Register Co., S. Main & K Sts., Dayton, Ohio, repair and modification of A-1A BNC (PR-735055), $5657758.

Aeroproducts Operations, GMC, Dayton, Ohio, spare parts for A644FN-C1 & A644 FN-C2 propellers, $63581.

Curtis Wright Corp., Caldwell, N. J., spare parts for CT735S propellers, $26638.

Decker Aviation Corp., 1361 Frankford Avenue, Philadelphia 25, Pa., Modification and repair of vertical gyros, (PR 735022), 500 ea, $37610.

Aeroproducts Operations, GMC, Dayton, 1, Ohio, Spare parts for A642G850 propellers, $414420.

Motorola Inc., 2710 Clybourn Ave., Chicago 14, Ill., Modification kits for AN/APS radar set. (PR-693260), $45582.

MIDDLETOWN AIR MATERIEL AREA, Olmsted Air Force Base, Pa.

Curtiss-Wright Corp., Wright Aeronautical Division, Wood Ridge, N. J., overhaul of J65 series aircraft engines PR 701673, Job, $1680000.

Minneapolis-Honeywell Regulator Co., Aeronautical Div., 2600 Ridgeway Road, Minneapolis 13, Minn. Repair of an/or technical order compliance on controls applicable to the type E-11 autopilot system PR 650952k, 243 ea., $30804.

OGDEN AIR MATERIEL AREA, Hill Air Force Base, Utah.

Link Aviation, Inc., Nolan Rtd., Hillcrest, Binghamton, N. Y. Contractual maintenance of flight simulators, Class 28A (contract AF 42 (600)-18333) $2651765.

John Mohr & Sons, Mohr Vacuum Process Div., 3200 E. 96th St., Chicago 17, Ill. Chamber, Class FSC 6910 (Contract AF 42(600)-18359, $115810.

SAN ANTONIO R&D PROCUREMENT OFFICE, Air Research & Development Command, P. O. Box 63, Lackland Air Force Base, San Antonio, Tex.

University of Utah, Salt Lake City, Utah, Development and evaluation of K-system trouble shooting performance testing procedures. (Contract AF 41657)-100) Job, $29952.

SAN ANTONIO AIR MATERIEL AREA, Kelly Air Force Base, Tex.

General Dynamics Corp. (Convair Div.) San Diego, Calif. Modification of C-131B Type Aircraft, Item 1, install electrical auxiliary power pod kits, 17 ea., item 2, install standard interior configuration modification kits, 15 ea. (PR 01-A-SA-641655 and SA-721712 (complete), $679,486.

AIR FORCE MISSILE TEST CENTER, Air Research and Development Command, Patrick Air Force Base, Fla.

General Dynamics Corp. (Convair Div.) San Diego, Calif., Increase in funds allotted (PR FP-1(56)-276, Job, $1,349,593.

Missileonics, Inc., Melbourne, Fla.

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DOVAP Beat-Beat Systems (PR FP-1 (56) (521), Job, $195792.

Cook Electric Co., Cook Research Laboratories Div., 2700 Southport Ave., Chicago 14, Ill., Increase in scope of work, extension of delivery schedule, increase in estimated cost fixed fee and funds allotted and modification of technical exhibit. (PR-1(56)-406, FP-1(56-534), Job, $81766.

Buzy Compressor Co., 1722 Cascade St., Erie, Pa., Compressor, (PR No. 19A-III-56-26000), $33500.

ROME AIR FORCE DEPOT, Griffis Air Force Base, N. Y.

The Siltronic Co., 2231 Saw Mill Run Blvd, Pittsburgh 10, Pa., Rack Relay MT-686/GR (RFP 30-635-56-5016Q), 945 ea, $113,985.

National Co., Inc., 61 Sherman Street, Malden 48, Mass., Standard, Atomic Primary Frequency NC1001 (RFP 30-635-56-4566Q), 3 ea., $135000.

Eastman Kodak Co., 343 State Street, Rochester 4, N. Y. Film 16mm X 1200 ft. type III, Class G (RFP 30-635-57-4112Q), 33493200 ft., $233112.

DAYTON AIR FORCE DEPOT, Gentile Air Force Station, Dayton 10, Ohio.

Jerrell-Ash Co., 26 Farwell St., Newtonville 60, Mass., spectograph JACO Wadsworth stigmatic grating spectograph contractor's model no. 7801 and including the accessories (RFP 33-604-56-4025), 3 ea, $41,895.

Tekronix Inc., P. O. Box 831, Portland 7, Ore. Oscilloscope 5 in screen Tekronix type 545 with type 53/54K plug in amplifier, 26 ea, oscilloscope Tekronix type 531 with type 53/54B plug in preamplifier 14 ea, commercial data (RfP 330604-56-4042) $56,358.

South Bend Current Controller Co., Inc., 1237 North Side Blvd., South Bend 15, Ind. Relay, switch solenoid, South Bend Current Controller type CPM-3-120, 100 ea, relay, switch solenoid, South Bend Current Controller type AN-2-120, 100 ea, RFP 32-604-56-3745, $36730.

Hewlett-Packard Co., 275 Page Mill Rd., Palo Alto, Calif., analyzer, harmonic wave Hewlett-Parkard model 300A (RFP 33-604-56-3755 50 ea., $35750.

PURCHASING AND CONTRACTING OFFICE, Sewart Air Force Base, Tenn.

Hardaway Construction Co., 105 S. 11th St., Nashville, Tenn., Construction of ILS facility IFB 40-602-56-114, Contract Nr. AF 40 (602)-449, job, $84,276.

ARMED SERVICES PETROLEUM PURCHASING AGENCY, Washington 25, D. C.

Wyandotte Chemical Corp., Wyandotte, Mich., Hydraulic Fluid, 12300 gals, $27,921.

Shell Oil Co., 50 West Street, New York 20, N. Y. The following award was issued under IFB 57-15: AV Gas 100/130, 120000 gals, Lube oil 1100, 1500 gals, $31,188.

Ashland Oil & Refining Co., 1401 Winchester Ave., Ashland, Ky., The following awards were issued under IFB 57-24: Av Fuel JP-4, 5000000, $500,000.

COMMANDER, HEADQUARTERS AMC., Wright-Patterson Air Force Base, Ohio.

The Rand Corp., 1700 Main St., Santa Monica, Calif., Air Defense system training (PR 669910), $13191987.

Pacific Airmotive Corp., 2940 N. Hollywood Way, Burbank, Calif., Iran Maintenance modification and test flight of C-47/C-117 type aircraft, (PR SB-554257), $662751.

Hayes Aircraft Corp., P. O. Box 2287, Birmingham, Ala., Iran Maintenance, Modification of C-119 type aircraft (PR MA-650776), $2690155.

Grand Central Aircraft Co., Glendale, Calif., Iran: C-45 Aircraft, Exercise, Option (PR697432), $536193.

Northwestern Aeronautical Co., Holman Field, St. Paul, Minn., Overhaul type R-985-1/3/39 aircraft engines type R-985-1/3, a/c, engines. Funds for CFE reimbursement, contract change notifications, (PR SA-5-0137, SA-715086, SA-541359 and 1, 2), $185,000.

Aerodex, Inc., International Airport, Mi-

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ami, Fla., Overhaul R-2800-CH16/103W, R-2800-99W, R2800-52W, aircraft engines, (Pr SA-560129, SA-715091, SA-560126), $637695.

Aerodex, Inc, International Airport, Miami, Fla., Overhaul of R2600-29 A/35 aircraft engines, (PR MA-650779), $950414.

Spartan Aircraft Co., Aviation Service Div., Municipal Airport, Tulsa, Okla., Overhaul of R2000-4 aircraft engines. Reclamation (Repetitious elements) R2000 aircraft engines (PR SA 560141), $752430.

Slick Airways, Inc., 3000 N. Clybourn Ave., Burbank, Calif., Overhaul of R1300-1A3 Aircraft engines (PR Ma-650778), $775572.

Lockheed Aircraft Service-International Inc., Jamaica 30, N. Y. Iran maintenance modification and flight test of T-29 type acft. (PR SA-546025-6, SA-697441), $724732.

Aircraft Engineering and Maintenance Company, Oakland Municipal Airport, Oakland, Calif., Iran Maintenance of T-33 type aircraft, (PR SM-536825), $2374072.

Southern California Aircraft Corp., Ontario International Airport, Ontario, Calif. Iran Maintenance of L-19 aircraft, (PR OC-Sm-536826), $504904.

Aero Corp., Atlanta Airport, Atlanta, Ga., Iran Maintenance of L-19 aircraft, (PR OC-705506-1), $128320.

Northwestern Aeronautical Company, Holman Field, St. Paul, Minn., Overhaul of R1820-76B, R1820-97, R1820-103, aircraft engines, (PR MA-650780), $140542.

Fontana Aviation, Inc., Ford Airport, Iron Mountain, Mich., Iran Maintenance of L-19 Aircraft, (PR OC-705507-1), $51166.

Lear Inc., Santa Monica, Calif., Iran Maintenance of L-19 aircraft, (PR OC-105505-1), $43579.

Lockheed Aircraft Corp., Marietta, Ga., Repair of acft. and nose fuselage and wing testing of Aeroproducts propeller. (PR PH-221798, PH-221788), $1257221.

ACF Industries, Inc. ERCO Division Hyattsville, Md., RC-135A type MB-26 flight simulators in a/W Contractor's report 6359-115, did 30 Apr. 56. (PR-PH-673011) 3 ea, $600000.

Temco Aircraft Corp., Greenville, Tex., Iran Maintenance, Fuel Tank Reseal and Reseal and Electronic modification of C-54 type aircraft, (PR SH-554254), $2425786.

Oakland Aircraft Engines Services, Inc., Oakland Airport, Oakland, Calif. Overhaul and conversion to R985 configuration of R985-1/3/39 aircraft engines. (PR SA-715087), $118392.

Reading Aviation Service Inc., P. O. Box 1201, Reading, Pa., Iran maintenance of C-13-A aircraft. (PR SA-697442), $148762.

Hayes Aircraft Corp., Birmingham, Ala., Iran maintenance and modification of KC-97 aircraft. (PR OC-705518), $2330388.

Temco Aircraft Corp., Greenville, Tex., Iran maintenance and modification of C-97 aircraft. (PR OC-705517), $2541886.

Fairchild Engine and Airplane Corp., Fairchild Aircraft Div., Hagerstown, Md. Rehabilitation modification and flight test of B-26C aircraft for MDAP., (PR SH-554223), $873772.

J. E. Sutherland, Sutherland Co., Peoria, Ill., Management Engineering services. (PR 709464), $107090.

Southern Airways School, Bainbridge Air Base, Bainbridge, Ga., Primary Pilot training school (PR 669991), $1400000.

Garner Aviation Service Corp., Barlow

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Air Base, Barlow, Fla. Primary pilot training school. (PR 669902), $1400000.

Pittsburg Institute of Aeronautics, Graham Air Base, Marianna, Fla. Primary pilot training school (PR669903), $1400000.

Texas Aviation Industries, Inc., Hondo Air Base, Hondo, Tex., Primary Pilot training school (PR 669904), $1400000.

Anderson Air Activities, Malden Air Base, Malden, Mo., Primary pilot training school (PR 669905), $1400000.

Beiser Aviation Corp., Marana Air Base, Marana, Ariz., Primary pilot training school. (PR 669906), $1400000.

Calif. Eastern Aviation, Moore Air Base, Mission, Tex., Primary pilot training school (PR 669907), $1400000.

Hawthorne School of Aeronautics, Spence Air Base, Maultrie, Ga., Primary pilot training school, (PR 669908), $1400000.

Serv. Air Aviation Corp., Stallings Air Base, Kinston, N. C., Primary pilot training school. (PR 669909), $1400000.

Resort Airlines, Inc., 1346 Connecticut Ave., Washington, D. C., Domestic Air Transportation Services, (PR 709107), $5264056.

Capitol Airways Inc., Berry Field, Nashville, Tenn., Domestic Air Transportation Services, (PR 709107), $3907022.

American Air Export & Import Co., P. O. Box 875, Miami, Fla., Domestic Air Transportation services, (PR 708107), $3965705.

Stock Transactions

Washington—Acquisition of 365,276 common shares of Northeast Airlines stock by the Atlas Corp. a beneficial owner, has been reported by the Securities and Exchange Commission. Atlas total holding is now 922,126 shares. George K. Gardner, officer and director, acquired 1,000 common shares through exercise of rights, making his total holding 16,000 shares.

Other transactions from Dec. 11 to Jan. 10 include:

Aero Supply Mfg. Co., Inc. Acquisition of 800 common shares by Henry Brightman, director for a total holding of 800; disposal of 2,100 common shares by Henmar Investing Co. for a holding of 24,485; acquisition of 1,300 common shares by Henry M. Margolis, director, for a direct holding of 37,411 and an indirect holding of 24,485; acquisition of 800 common shares by Leo Struss, officer and director, for a direct holding of 18,572 and an indirect holding of 24,482.

Aeronca Mfg. Corp. Disposal of 2,000 common shares by Gordon J. Wolf, director, leaving a holding of 5,150.

Air Reduction Co. Inc. Disposal of 1,000 common shares by C. DeWolf, Gibson, officer and director, leaving a holding of 2,000; disposal of 500 common shares by John A. Hill, officer and director, leaving a holding of 6,345.

Allegheny Airlines Inc. Acquisition of 1,000 common shares by Willard F. Rockwell, Jr., director, for a holding of 16,000.

American Bosch Arma. Acquisition of 500 common shares through exercise of option by Clifton T. Foss, officer, for a holding of 2,100; acquisition of 1,000 common shares by Kenneth F. Leaman, officer, for a holding of 1,050.

Avco Manufacturing Corp. Acquisition of 700 common shares by A. B. Newton, officer, for a holding of 900; acquisition of 400 preferred shares by A. B. Newton, officer, for a holding of 400.

Beech Aircraft Corp. Acquisition of 100 common shares by Leddy Greever, officer, for a holding of 225.

Bendix Aviation Corp. Acquisition of 1,123 common shares through exercise of option by Marvin A. Hedit, officer, for a holding of 2,428.

Boeing Airplane Co. Disposal of 120 capital shares by Dietrich Schmitz, director,

leaving a holding of 6,000; disposal of 20 capital shares by J. O. Yeasting, officer and director, leaving a holding of 2,507.

California Eastern Aviation. Disposal of 1,000 common shares by S. J. Solomon, & Sons Inc., holding company, leaving a holding of 9,415, with S. J. Solomon, officer and director, holding 28,415 common shares.

Capital Airlines, Inc. Disposal of 1,500 common shares by Charles H. Murchison, director, leaving a holding of 8,132.

Continental Aviation & Engineering Corp. Acquisition of 200 common shares by Robert J. Brooks, Jr., director for a holding of 200.

Curtiss-Wright Corp. Acquisition of 500 common shares by James G. Byron, officer and director, through exercise of option, for a holding of 2,500; acquisition of 1,500 common shares through exercise of option by Thomas C. Coyne, officer, for a holding of 5,300; acquisition of 800 common shares through exercise of option by Jack C. Charshafian, officer, for a holding of 1,500; acquisition of 2,000 common shares through exercise of option by W. Kenneth Houpt, officer, for a holding of 2,900; acquisition of 2,000 common shares through exercise of option by Sam D. Erwin, officer, for a holding of 4,200; acquisition of 400 common shares followed by disposal of 400 common shares into a trust for children by William T. Lake, officer, leaving a holding of 600 for Lake and making a holding of 400 for the trust; acquisition of 1,500 common shares through exercise of option by Wilton O. Lundquist, officer, for a holding of 1,500; acquisition of 300 common shares through exercise of option by Joseph V. Miccio, officer, for a holding of 3,300; acquisition of 1,000 common shares through exercise of option by Gordon J. Staub, officer, for a holding of 1,180.

Douglas Aircraft Co. Inc. Disposal of 200 capital shares by Donald W. Douglas, Jr., officer and director, leaving a holding of 1,050.

Eastern Airlines Inc. Disposal of 100 common shares and acquisition of 300 common shares by Joseph H. Brock, officer, for a holding of 1,103; acquisition of 600 common shares by L. S. Rockefeller Trust for a holding of 3,342, with L. S. Rockefeller, director, holding 91,800 common shares.

Emerson Electric Manufacturing Co. Disposal of 11,250 common shares in a private sale by Mills Inc., beneficial owner, leaving a holding of 130,000.

Fairchild Engine and Airplane Corp. Acquisition of 100 common shares by P. S. Cleveland, officer, for a holding of 213; acquisition of 300 common shares by William Preston Lane, Jr., director, for a holding of 1,300.

Flying Tiger Line. Disposal of 200 common shares by Oswald R. Burghardt, officer, leaving a holding of 325.

General Dynamics Corp. Acquisition of 15,000 common shares through exercise of option by Earl D. Johnson, officer and director, for a holding of 30,000; acquisition of 10,000 common shares through exercise of option by Allen D. Marshall, officer and director, for a holding of 19,750; acquisition of 1,000 common shares, disposal of 500 common shares and acquisition of 1,500 common shares by Robert C. Tait, officer and director, for a holding of 8,925; acquisition of 3,000 common shares by Robert B. Watts, director, for a holding of 7,140; acquisition of 2,500 common shares through exercise of option by Lisle W. Adkins, officer, for a holding of 2,500.

General Electric Co. Acquisition of 2,250 common shares by Lemuel R. Boulware, officer, for a holding of 6,750; acquisition of 990 common shares through exercise of option and disposal of 76 common shares by Edwin H. Howell, officer, leaving a holding of 1,535; disposal of 200 common shares by Clarence H. Linder, officer, leaving a holding of 6,410; acquisition of 822 common shares through exercise of option and disposal of 1,900 common shares by Chauncey Guy Suits, officer and director, leaving a holding of 3,010; acquisition of 1,695 common shares through exercise of option by William C. Wichman, officer for a holding of 4,298.

Grumman Aircraft Engineering Corp. Disposal of 1,000 common shares by L. B. Grumman, director, leaving a holding of

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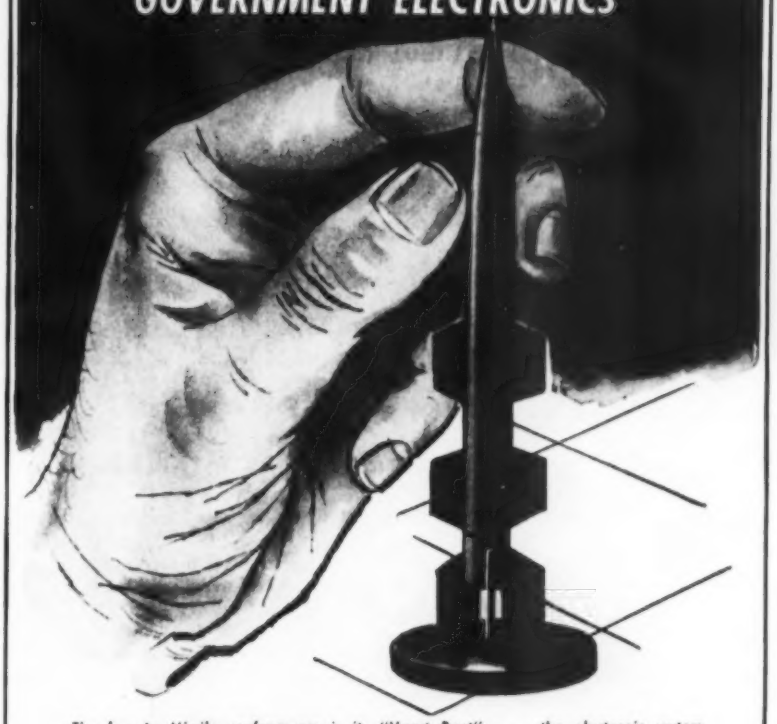

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153,580; acquisition of 500 common shares by Robert L. Hall, officer, for a holding of 1,050.

Lear Inc. Acquisition of 1,000 common shares by Roy J. Benecchi, officer, for a holding of 2,881; acquisition of 2,500 common shares by Andrew F. Haiduck, officer, for a holding of 7,671; disposal of 1,200 common shares by Richard M. Mock, officer, leaving a holding of 15,660.

Lockheed Aircraft Corp. Disposal of 400 capital shares by Harve R. Campbell, officer, leaving a holding of 270; disposal of 500 capital shares by Cyril Chappellet, officer and director, leaving a holding of 9,771.

Glenn L. Martin Co. Disposal of 1,000 common shares by Jess W. Sweetser, officer, leaving a holding of 5,565.

McDonnell Aircraft Corp. Disposal of 200 common shares by Kendall Perkins, officer and director, leaving a holding of 1,800.

Northrop Aircraft Inc. Acquisition of 1,320 common shares by Edgar Schmued, officer, for a holding of 3,100.

Pan American World Airways Inc. Acquisition of 750 capital shares through exercise of option by Alvin P. Adams, officer, for a holding of 2,459; acquisition of 500 capital shares through exercise of option by Russell B. Adams, officer, for a holding of 2,040; acquisition of 500 capital shares through exercise of option by Henry H. Berke, officer, for a holding of 2,505; acquisition of 133 capital shares through compensation by Everett M. Goulard, officer, for a holding of 478; disposal of 300 capital shares by John C. Leslie, officer and director, leaving a holding of 5,725.

Piasecki Aircraft Corp. Disposal of 500 common shares by Donald N. Meyers, officer, director and beneficial owner, leaving a holding of 44,067.

Piper Aircraft Corp. Acquisition of 100 common shares by W. T. Piper, Jr., officer and director, for a holding of 2,622 with 18,000 common shares in voting trust.

Radio Corp. of America. Acquisition of 100 common shares by Charles B. Jolliffe, officer and director, for a holding of 963.

Raytheon Manufacturing Co. Disposal of 500 common shares by Paul F. Hannah, officer, leaving a holding of 124; disposal of 1,000 common shares by Percy L. Spencer, officer and director, leaving a holding of 1,313.

Rohr Aircraft Corp. Disposal of 2,000 common shares by J. E. Rheim, officer and director, leaving a holding of 28,235.

Skiatron Electronics & Television Corp. Acquisition of 10,000 common shares through exercise of option by Arthur Levey, officer, director and beneficial owner, for a holding of 451,581.

Slick Airways Inc. Disposal of 1,000 common shares by D. J. Guth, officer, leaving a holding of 428; disposal of 200 common shares by Charles T. Leigh, director, leaving a holding of 110.

Sperry-Rand Corp. Disposal of 800 common shares by Harry Landsiedel, officer, through a joint tenancy, leaving a holding of 33,000 for the joint tenancy and 13,904 for Landsiedel.

Sylvania Electric Products. Disposal of 100 common shares by Don G. Mitchell, officer, leaving a holding of 4,231.

Trans World Airlines Inc. Disposal of 300 common shares by Warren Lee Pierson, officer and director, leaving a holding of 201.

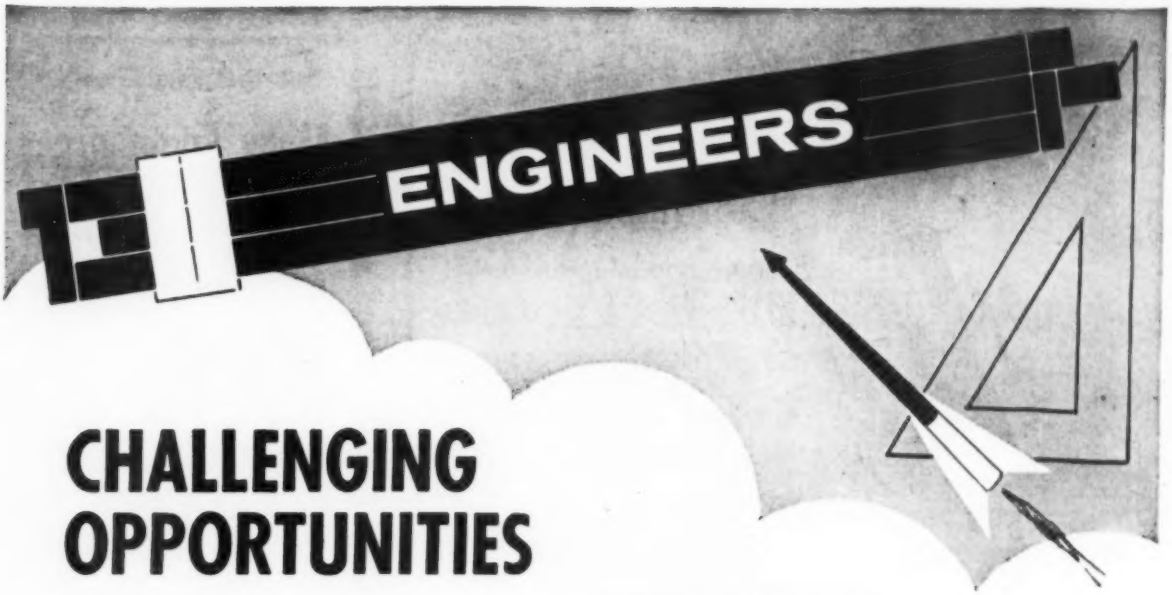
United Airlines Inc. Disposal of 200 common shares by R. F. Ahern, officer, leaving a holding of 2,502; disposal of 200 common shares by D. R. Petty, officer, leaving a holding of 1,015.

United Aircraft Corp. Disposal of 500 common shares by William P. Gwinn, officer, leaving a holding of 4,720; acquisition of 3,000 common shares through exercise of option by Leonard S. Hobbs, officer and director, for a holding of 6,000.

Valspar Corp. Acquisition of 500 common shares by Certain-Teed Products, beneficial owner, for a holding of 383,065.

Western Airlines. Acquisition of 260 common shares through exercise of option by C. J. Cox, officer, making a holding of 1,560; disposal of 500 common shares by D. P. Renda, officer, leaving a holding of 1,061.

Westinghouse Electric. Acquisition of 1,000 common shares by John M. Schiff, director for a holding of 11,500.



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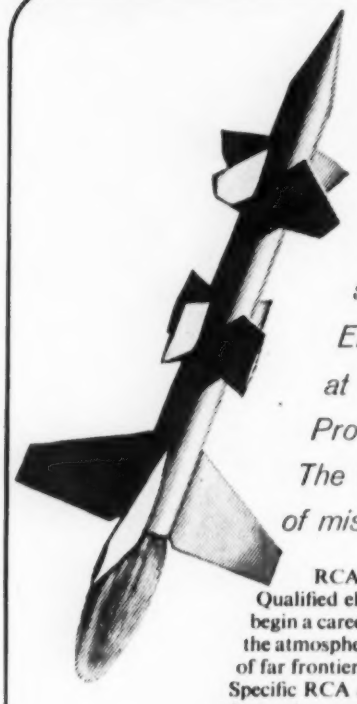

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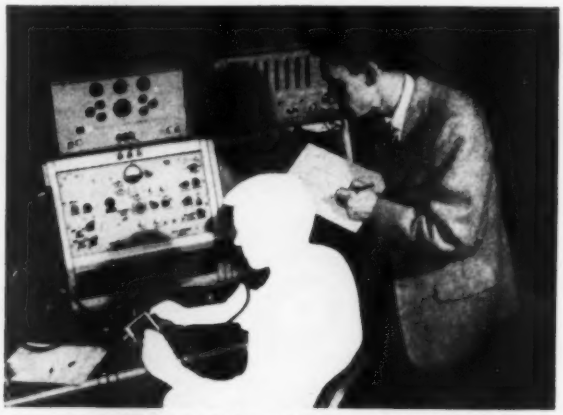

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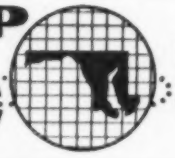

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IMPORTANT ACHIEVEMENTS AT JPL

Development of the Sergeant

Announced as a successor to the Corporal is another highly accurate surface-to-surface ballistic missile named "The Sergeant." This weapon will continue the United States Army's advance in the development of mobile firepower.

The latest techniques in guidance, airframe design and rocket propulsion are being applied to the development of this rugged weapon which is capable of operating in any area.

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Silver Spring, Maryland

LETTERS

Reminder

It was with considerable indignation that I read the article on p. 51 of your Feb. 4 issue entitled "New Interiors Designed for Viscounts." I think you will readily agree that the most important feature of any commercial aircraft interior is the seats in which the paying passengers ride. We find it difficult to understand, therefore, how an article such as this could overlook mentioning the fact that these particular passenger seats were designed and developed by the Aerotherm Corporation especially for Continental Air Lines.

We do not mean to criticize in any way the other content of the article as regards its description of the interior cabin covering, color schemes and various appointments described therein. We mean only to voice a complaint that the name of Aerotherm was entirely omitted and credit not given where credit is due. We are proud of the Aerotherm name and understandably want to see it displayed whenever and wherever it can benefit our company and its products. This is why we buy space in AVIATION WEEK from time to time.

As a matter of fact, the relationship between Aerotherm aircraft seats, both passenger and crew, and Vickers-Armstrongs' Viscount airplanes is a long standing one. Aerotherm seats have to date been installed in, or ordered for, no less than 15 operators of Viscount airplanes.

You can see, therefore, that our omission from this Feb. 4 story prompts us to write you this reminder.

M. J. DODD, SALES MANAGER
Aircraft Division
The Thermix Corp.
Greenwich, Conn.

On Same Level

From this neutral corner may I suggest that the man who stooped low enough to print the letter captioned "Rockets' Red Glare" (AW Jan. 7, p. 138) is almost on a level with the individual who wrote it.

The Russians must enjoy such "pleasantries." But true friends of aviation on both sides of the Atlantic can only feel ashamed.

GEORGE FULLER
129 Vivian Ave.
Montreal 16, Canada

NACA "Statistic"

As a statistic in some of the figures accompanying the article "NACA Says Loss of Scientists Threatens U. S. Lead" (AW Feb. 11, p. 86-87) I feel compelled to comment.

I am sure that many of us who have left the NACA have a recurrent sense of guilt about leaving one of the finest research organizations in the United States when we know that it desperately needs its personnel.

However, every man must determine to what extent he should ask his family to sacrifice the so called "niceties of life" so that he may enjoy a more idealistic and technically rewarding career. Although the NACA supplements a man's income with increased technical advancement and a large measure of personal satisfaction, these abstract qualities unfortunately only provide a means of increasing the family living standard by the man leaving to work in industry.

I hope that the statistics continue to stimulate concern over the NACA personnel problems and illustrate the monetary sacrifice that is being made by those who have remained there.

Further, I hope that the statistics provide a tool to unsaddle the NACA from its present salary structure burden and allow it to compete with industry for outstanding college graduates and improve the economic status of those presently there. Those who have remained there certainly deserve more than a pat on the back.

EX-NACA EMPLOYE

Aviation Week welcomes the opinion of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42 St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Altitude Accuracy

We have noted with interest that your correspondent, Mr. Everett H. Schroeder of the Kollsman Instrument Corp., in a letter published in the Nov. 26 issue, claims that the Kollsman Integrated Flight Instrument System gives altitude information with an accuracy of plus or minus 100 ft. at 40,000 ft.

From existing published information on the Kollsman IFIS, we feel that this claim may well be subject to some qualification. For example, so far as we are aware no account is taken of the effects of variation in air density due mainly to changes in outside air temperature. This alone over the non-extreme range of 10C below to 10C above ICAO Standard can result in indications which would be in the order of 1,480 ft. above or below the geopotential altitude (i.e. true altitude as defined by ICAO Standards).

Again, since the description of the IFIS (AW March 5, 1956, p. 69) and accompanying illustration (p. 71) show that "well-tried, acceptably accurate, pure pressure instruments" are used, it is difficult to see how certain errors inherent in the use of apparently conventional capsules, gears and linkages can be corrected for by integration or the use of cams. Reference to the First Interim Report of the ICAO Panel on Vertical Separation shows that the following errors may be assumed for a better than average instrument at 40,000 ft.

1. Diaphragm and hysteresis	650 ft.
2. Friction	100 ft.
3. Backlash	100 ft.
4. Instability	100 ft.
5. Zero-setting	20 ft.

Allowing that the effect of No. 1 is reduced by 90%, statistical addition of these errors alone by the method described in the report results in a combined possible error of 230 ft.

Referring to Mr. Schroeder's statement that most of the variation in altimeter readings experienced by eight F-80s at 36,000 ft. were caused mainly by variations in the airplane static systems, we would point out that a variation of 2,000 ft. at 36,000 seems excessive having in mind the requirements of specification MIL-I-6115A. This calls for a maximum variation of 50 ft. altitude due to position error for a given aircraft type. Errors between successive aircraft of the same type are considered to be negligible, yet an error of plus and minus 1,000 ft. above and below 36,000 ft. is equivalent to a pressure difference of over .64 inches of mercury!

P. HOBLEY
R. H. BAYLIS
Canadian Aviation Electronics Ltd.
Montreal, Canada

Subsidized Recruiting

AVIATION WEEK should be congratulated for exposing the fatuous conditions surrounding engineer procurement by a majority of the aircraft and missile organizations (AW Jan. 21, p. 97). After the hiring of thousands of technicians during World War II, it would seem logical that the experience gained in that operation would be translated into a modicum of efficiency at the present time.

Advertisements to lure engineers into accepting employment are typical of the puerile thinking that has infected aviation personnel relations for the past 25 years. The general premise that it is better to hire two low priced technicians in place of trained high priced technicians does not reflect any change in aviation thinking since the inception of the industry when the greatest danger to those in it was starvation.

Most of these advertisements reflect poor taste in presenting a sales pitch to a prospective employe. After all, engineers are intelligent people, although an examination of the advertising copy would lead one to believe that they had a subnormal IQ. And from the way prospects report, the treatment they receive in applying for these glamorous jobs is sometimes insulting.

Your article by Max Pape is to the point and exposes a vital weakness in our industrial organization. But will anything be done to correct this glaring weakness? No. Nothing will be undertaken to correct this malpractice as long as each company that receives a cost-plus-fixed-fee government contract is permitted the luxury of these ineffective indulgences at the taxpayer's expense.

It's time for a change! The enticing giveaways that various companies promise all come out of the taxpayer's pocket. Aviation management has always been reluctant to share the wealth unless it belonged to Uncle Sam.

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It can airlift up to 20 tons of cargo swiftly and efficiently – and make parachute drops for on-the-spot aerial delivery.

It's the great new "workhorse" of the Air Force–Lockheed's versatile C-130 Hercules–now being delivered to the Tactical Air Command's 18th Air Force at Ardmore Air Force Base, Oklahoma.

Powered by four 3,750-horsepower Allison T56 Prop-Jet engines driving three-bladed Aeroproducts Turbo-Propellers, the C-130 attains speeds of over 350 miles per hour–more than 100 miles per hour faster than other tactical transports. *And it does this at less than half the ton-mile cost of its nearest competitor.*

A commercial version of the T56–Allison's Model 501 Turbo-Prop engine powering the new Lockheed Electra–will bring jet-age speed and luxury to commercial service, with new smoothness and quiet on flights now serving 98% of the nation's commercial passenger traffic. 128 of these new luxury airliners have been ordered by six major airlines.

This great new concept in aircraft power reflects Allison's unmatched experience in the design and development of aircraft turbine engines and turbo-propellers.

ALLISON DIVISION OF GENERAL MOTORS–Indianapolis, Indiana

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